

PROCEEDINGS  
SUMMER INSTITUTE  
ON  
NONTRADITIONAL DIVERSIFIED FISH  
PRODUCTS & BYPRODUCTS

27 APRIL TO 26 MAY, 1981

CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY

COCHIN - 682 029







SUMMER INSTITUTE IN  
NON-TRADITIONAL DIVERSIFIED FISH PRODUCTS  
AND BY-PRODUCTS

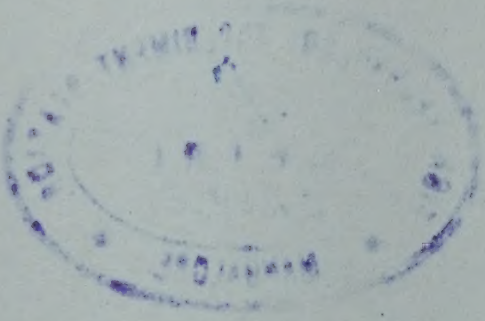
HELD AT

CENTRAL INSTITUTE OF FISHERIES TECHNOLOGY, COCHIN

From 27 April to 26 May 1981

Director of the Summer Institute: M.R.NAIR.

Central Institute of Fisheries Technology  
Indian Council of Agricultural Research  
Matsyapuri P.O. COCHIN-682029. INDIA.



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## PREFACE

The Indian Council of Agricultural Research has been supporting Summer Institutes since 1967 in the field of Agricultural and animal sciences including fisheries for the benefit of teachers, research workers and extension workers particularly subject matter specialists. The main objectives of this in-service training course are to communicate the latest technological advances in the subject and to provide the necessary orientation to the teachers and research workers so that they are able to relate their work to the contemporary problems in their respective field through an enlightened understanding of the subject.

This year the ICAR has sanctioned 21 such summer Institutes in the various disciplines of Agricultural Sciences of which two are in fisheries. On the post-harvest technology of fish, the Central Institute of Fisheries Technology has conducted a Summer Institute in Fish Processing Technology in 1978. The recently conducted Summer Institute in "Non-Traditional Diversified Fish Products and By Products" is a more specific course in Fish Processing Technology.

The Central Institute of Fisheries Technology has been undertaking work on the development of non-traditional products and by products from fish and fish processing waste and considerable progress has been achieved in this direction. The techno-economic feasibility of some of the processes evolved was also tested under field conditions, which facilitated the Institute to transfer the technologies to the entrepreneurs. It is the dire need of the hour to bring in a greater awareness towards

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product diversification in Indian Sea Food industry not only for sustenance but also for any future expansion. There is vast scope for expanding the consumer sector in both traditional and non-traditional marine products.

The topics covered in the syllabus for the Summer Institute have been carefully identified and the theory classes, group discussion and practical training were arranged in such a manner that the participants would develop a direct sense of participation and acquire the required knowledge and practical skill on the implementation of the technology.

M.R.NAIR

DIRECTOR, SUMMER INSTITUTE

CIFT,  
COCHIN.

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EXCERPTS FROM THE INAUGURAL ADDRESS BY SH. S. N. RAO  
ON 27-4-1981

Prof. Samuel, Shri M.R.Nair, Dr. Raghu Prasad,  
Dr. Gopakumar and friends,

I feel it a honour to be invited to inaugurate this Summer Institute on non-traditional diversified fish products and by-products. I am happy to note that this Institute has attracted technical officers from different organisations. The subject selected for this Institute is quite topical.

As is well known the fishery industry in India has been concentrating on a few traditional items. Years back there was a flourishing trade in dried fish and fish products. During the last three decades or so, an industry based on shrimp was developed in the country due to the demand in foreign markets. While the trade in frozen shrimp has been going steady so far the trade in canned shrimp has shown considerable decline after 1974 due to our inability to compete in the international markets. Similarly our effort to export sardine, mackerel etc. have not succeeded in spite of the fact that the Govt. have allowed liberal subsidy for exporting these items.

In the matter of fishing also we have been exploiting only the inshore waters using traditional craft and gear and also small mechanised shrimp boats. Only during the last five years especially in the State of Karnataka, purse seining for sardines and mackerels has become popular. Thus the supply of raw material to the fish processing industry has also been so far from the above conventional resources. There is urgent need to diversify our fishing effort.

In the matter of deep-sea fishing also we have to make a break-through. There are hardly 70 vessels in the country which can exploit the resources in off shore regions. Even these vessels have been operating as shrimp trawlers only. Though our exploratory surveys have indicated adequate deep sea resources, no efforts have so far been made to commercially exploit these. Economic viability of deep sea fishing projects is yet to be proved.

However, in the matter of developing processing technology for utilisation of all the resources available in our waters we have achieved very good progress. Pioneering work has been done in the Central Institute of Fisheries Technology, Cochin, in the Central Food Technological Research Institute, Mysore and also the College of Fisheries, Mangalore, for developing methods of utilisation of fishery resources available to us.

I find that the curriculum for this Summer Institute has been drawn by the Senior Scientists of the Central Institute of Fisheries Technology and as such it is quite comprehensive in its scope.

I am sure that the participants in this Summer Institute will find the course offered by the CIFT quite useful. There can-not be a better venue for holding this summer institute than the CIFT, Cochin as this is premier institute of its kind in India. The institute has developed processing techniques not only for fishery products meant for human consumption but also developed methods of utilising fishery waste from processing plants and non-edible material from the sea for industrial purposes.

I am, therefore, sure that after completing this course the participants can go back to their respective organisations and apply the knowledge gained here in their own areas of interest. With these few words I formally inaugurate the summer Institute and wish the institute all success.

DR. C.T. SAMUEL' S PRE SIDENTIAL ADDRESS ON 27-4-'81

I would like to express my appreciation to the C.I.F.T. for choosing a subject of much contemporary importance. The initial rapid growth shown by the seafood industry suddenly ended and a decline has already set in. The gradual and steady increase in the total marine fish landings in India has also ended and there are already indications of a decline in the landings of some of the important commercial fish species in India. When the species which constitute the raw-materials for the seafood industries do not show any promise of increase in landings, the two possibilities are increased yield from mariculture and coastal culture and utilisation of other readily available resources. Though India has made much progress in aquaculture, the yields from the farms have not made substantial addition to the raw material resources for the fisheries industry. Similarly, though several isolated efforts were made to develop and market non-traditional fish products and by products, none other than the frog legs made a success in the industry. The need and the scope for non traditional items of fish products as a means of diversification of the seafood industry are more keenly felt at present than at any time in the past due to the decline in the export trade of fishery products from India in 1980-81. So it is the most appropriate time to share the expertise of the C.I.F.T. in non-traditional fish products with other fisheries institutions and the fisheries industry.

The production and marketing of non-traditional fish products in India started with the modern Seafood industries. In a broad sense, even the frozen shrimps are non-traditional products. Even though a total of around sixty Seafood products are exported, only a few frozen fish products have a regular export market. The failure of these products need not be attributed only to the quality of the fishery products, because there are many factors which influence the success of a food product in the market. CIFT is primarily concerned with the development of fishery products and their quality, and so it is essential to collaborate with the marketing agencies for assessing the acceptability of the product in the market.

Any study on a fishery product should be based on the availability and quality of the raw-material. India has only less than ten species of marine animals which are available in sufficient quantities to support even medium size industries. None of these species are available throughout the year. So the industries cannot afford to be too large and they should have sufficient facilities to process alternate resources, if one fails. Spare and unutilised capacity are the main problems confronting the seafood industry in India.

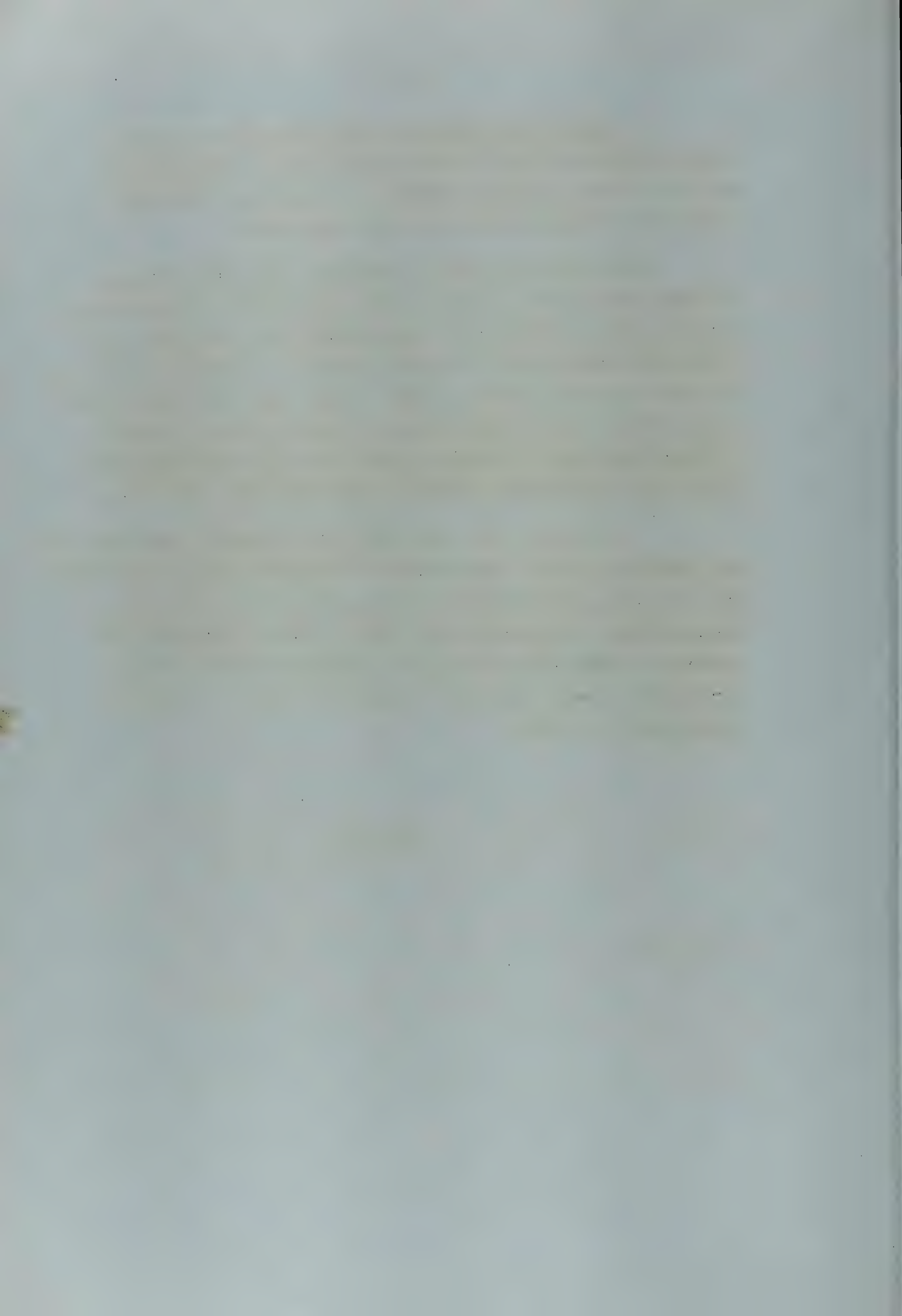
So also the limited quantities of raw-materials prevent the use of mechanisation of the preliminary cleaning of the raw-materials. None of the seafood industries in India need a peeling machine for shrimps; This necessitates the employment of human labour for handling and cleaning the raw materials.

The development of new or non-traditional fish products should also consider the acceptability in the market whether Indian or foreign. The MPEDA could be of great help for this purpose.

The CIFT will have a fairly long list of non-traditional items. The modern techniques of production management, economics of production and marketing and marketing techniques will be needed to establish any new product in the market. Some of the products which have scope for a good market can be tried in the initial stages and other products could be taken up depending upon the experience gained by the initial efforts.

I do hope and wish that this Summer Institute will be able to impart much useful information and experience to all the participants in the production of non-traditional fish products. May I also wish that this effort of the CIFT will give a fresh impetus to the production and marketing of non traditional fishery products in India.

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## SYLLABUS AND MEMBERS OF FACULTY

### SYLLABUS

#### THEORY

1. Studies of diversified products in fish processing industry. M.R.Nair 1½ hrs.  
Pattern of utilisation of fish in India-Export figures-quantity and value- Scope for product-development - fish frozen in different forms-Canned fish -dried, smoked and pickled products-utilisation of trash fish-shark fins-fish oil- utilisation of processing waste.
2. By Products Technology and waste utilisation in fisheries industry. P.V.Prabhu 1½ hrs  
Studies of fish processing industry in India-Development of fishery by products-Shark liver oil-Sardine body oil- fish maws-prawn shell and head waste-utilisation of squilla-future prospects.
3. Technology of production of minced fish meat from lost cost fish and its storage characteristics. P.A.Perigreen 1½ hrs  
Principles of meat separation-meat picking machine-production techniques-yield of meat from different varieties-quality of picked meat.- freezing of minced meat in blocks-changes during frozen storage-utilisation as base material for different preparations.
4. Technology of production of fish Wafers and fish soup powder. K.Gopakumar 1½ hrs  
Minced fish meat-preparation into fish wafers-fish soup powder-shelf life of preparations-prospects of production in small scale sector.
5. Production techniques of fish hydrolysate K. Gopakumar 1½ hrs  
Principles involved-acid and alkali hydrolysis-Role fish enzymes in protein hydrolysis-commercial methods of fish hydrolysate production using bromelain and papain-use of fish hydrolysates.

6. Fish protein concentrate-production, problems and Prospects.

K.Gopakumar

1 1/2 hrs.

Definition of FPC-Historical-viobin and Canadian processes-CITRI and CIFT methods of production of FPC --product quality-grading, shelf-life-uses of FPC--prospects of market.

7. Paste fishery products and fish fingers

P.A.Perigreen

1 1/2 hrs.

History-products developed in different countries-Kamaboko, Chikuwa-Hanpen-'Satsuma-age'-Sumaki Tunapaste-Sardine paste-packaging of the products-composition and storage life-preparation of fish fingers-requirements of batter and breading material-shelf life at frozen temperatures.

8. Diversified fishery products with special reference to microbial quality.

C.C.P.Rao

1 1/2 hrs.

Effect of freezing and frozen temperatures on bacteria-microbial spoilage in canned fishery products-bacteria associated with salted and dried fish-moulds in salted fish-aflatoxicism-occurrence of coliforms in bivalves-incidence of vibrio parahaemolyticus-potential pathogenicity of molluscan shell fish.

9. Role of fishery waste in animal feeds.

K.G.R.Nair

1 1/2 hrs.

Fish meal-composition and uses-formulation of cattle and poultry feeds-fish ensilage as animal feed-liver oil-protein from prawn shell waste and squilla-uses of cartilagenous material left from shark fish processing.

10. Production of shark fin rays.

P.Madhavan

1 1/2 hrs.

Processing of shark fins-commercial value of fins-grading-preparation of fin rays+1 and uses-market demand of shark fins and rays.

11. Utilisation of prawn shell waste

P.Madhavan

1 1/2 hrs.

Preparation of shrimp extract from prawn shell waste-chemical nature of chitin and chitosan-preparation of chitin, chitosan and glucosamine hydrochloride-quantitative yield-pilot plant for production of chitosan.

12. Potential uses of Chitin and Chitosan

K.G.R.Nair

1 1/2 hrs.

Molecular properties of chitin and chitosan-uses in ion exchange chromatography-uses as paper and textile additive-application in glass fabrics, photography-as industrial coagulant-medical applications.

13. Prospects of fish meal and fish oil industry in India

U.S.Kini

1 1/2 hrs.

World production of fish meal and fish oil-requirements of fish meal as live stock feed-analytical methods-fish meal industry in India-Planning for future-utilisation of sardine oil-Analytical characteristics of products developed-Hydrogenation of fish oil.

14. Fish and Shell fish pickles

K.K.Balachandran

1 1/2 hrs.

Preparation of fish pickles- composition-storage and shelf life-prawn pickle-clam and mussel meat pickle-popularisation of the low cost technology.

15. Canning techniques for clam and mussel meat

K.K.Balachandran

1 1/2 hrs.

Availability of raw material suitable for canning-processing techniques-composition and shelf life of the products developed.

16. Manufacture of fish sausage

T.M.Rudra Setty

1 1/2 hrs.

Technology of fish sausage preparation-role of preservatives-Indian fishes suitable for sausage preparation-Bacteriological considerations-Composition of sausage-Types of spoilage in sausage.

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Total: 24 hrs.

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# PRACTICAL

1. Preparation of minced meat from fish	9 hrs.
2. Preparation of fish wafers	8 hrs.
3. Preparation of fish soup powder	
4. Preparation of fish hydrolysate	3 hrs.
5. Preparation of fish flour	9 hrs.
6. Preparation of fish fingers	3 hrs.
7. Preparation of shark fin rays	3 hrs.
8. Formulation of poultry feed	3 hrs.
9. Preparation of glucosamine hydrochloride	3 hrs.
10. Preparation of Chitosan	9 hrs.
11. Preparation of fish pickle	3 hrs.
12. Preparation of canned clams and mussels	6 hrs.
13. Visit to local Fisheries Institutions	6 hrs.
14. Visit to fishing villages, fish processing plants and fishery harbour	8 hrs.
15. Field Visit to Krishivigyan Kendra and Fish Farm of CMFRI at Narakkal and Fish Meal Plant and Regional Shrimp Hatchery at Azhikode.	8 hrs.
16. Audio Visuals	6 hrs.
17. Group discussion and Library Work	31 hrs.
18. Evaluation Tests	6 hrs.

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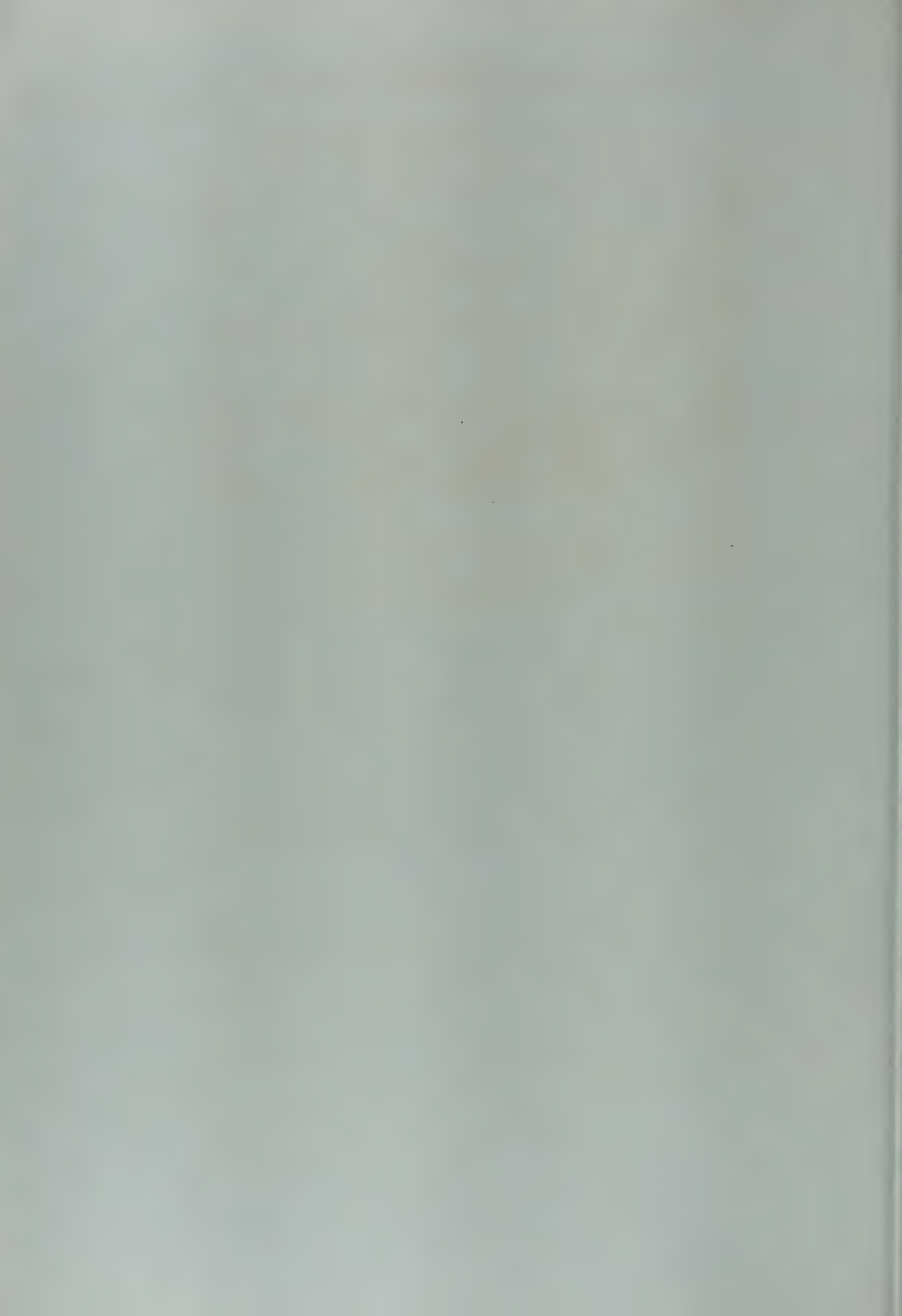
Total: 124 hrs.

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MEMBERS OF FACULTY

Shri M.R.Nair, CIFT, Cochin.  
Dr.K.Gopakumar, CIFT, Cochin.  
Shri P.Madhavan, CIFT, Cochin.  
Shri K.G.Ramachandran Nair, CIFT, Cochin.  
Shri P.V.Prabhu, CIFT, Cochin.  
Shri K.K.Balachandran, CIFT, Cochin.  
Shri P.A.Perigreen, CIFT, Cochin.  
Shri A.V.Shenoy, CIFT, Cochin.  
Shri P.K.Vijayan, CIFT, Cochin.  
Shri P.T.Mathew, CIFT, Cochin.  
Shri T.K.Thankappan, CIFT, Cochin.  
Shri S.M.S.Abuthahir Ali, CIFT, Cochin.  
Smt. R.Thankamma, CIFT, Cochin.



Summer Institute on  
"Non Traditional Diversified Fish Products & By-products"

List of Participants

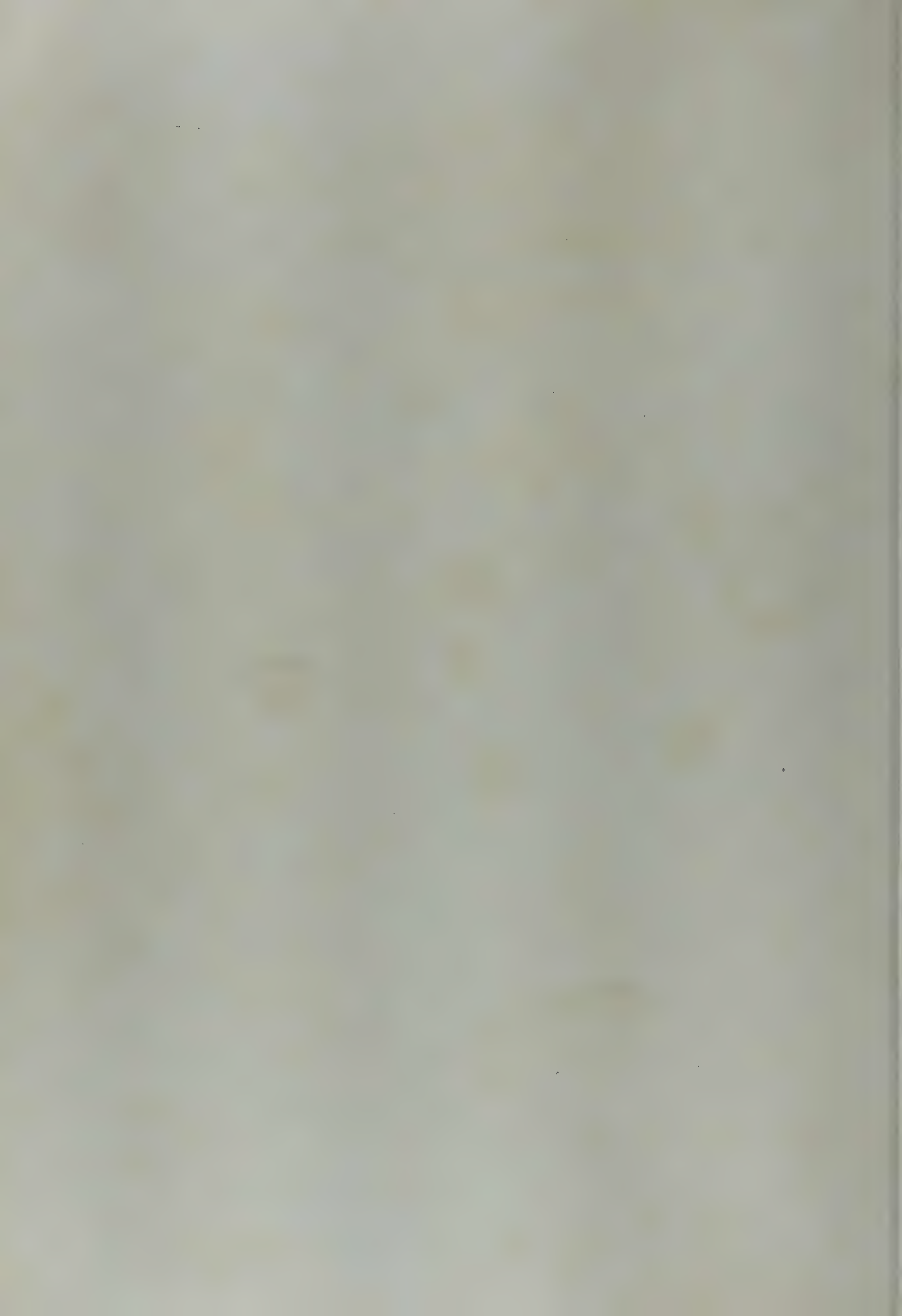
<u>Sl. . No.</u>	<u>Name and address</u>	<u>Sponsored by</u>
1.	Mrs. B.Ambika Nair, Lecturer in Food Science, Food Craft Institute, Kalamassery, Alwaye-4	The Principal, Food Craft Institute, Kalamassery, Alwaye-4.
2.	Sri C.Aswathanarayana, Superintendent of Fisheries, Markonahalli P.O., Kunigal, Tumkur Dist., Karnataka State	The Director of Fisheries, Karnataka, II Floor, Vidhanaveedhi, Bangalore-560001
3.	Sri Ansuman Hajra, Scientist, CIFRI, Barrackpore 743101 (W/Bengal)	The Director, CIFRI, Barrackpore 743001 (W/Bengal)
4.	Smt. V. Bhuvaneswari, Assistant Professor, Sri Avinashilingam Home Science College, Coimbatore-641043	The Principal, Sri Avinashilingam Home Science College, Coimbatore-641043
5.	Sri S. Dhnanajaya, Instructor-in-Freezing, College of Fisheries, Mangalore-575001.	The Director of Instruction, College of Fisheries, Mangalore-575001
6.	Dr. M.C. George, Asst. Professor, College of Fisheries, Mannuthy 680651, Trichur Dist.	Dean, College of Fisheries, Kerala Agrl. University, Mannuthy 680651
7.	Sh. M. Haridas Bhandary, Instructor, College of Fisheries, Technology Wing, Hoige Bazar, Mangalore 575001	Director of Instruction (Fisheries), College of Fisheries, Mangalore 575001
8.	Sh. M. Kingsley Laine, Research Assistant, Fisheries Technological Station, Tuticorin-1.	The Director of Fisheries, Teynampet, Madras-6.

9. Sh. K.A.Krishna Kumar,  
Manager-in-charge,  
Diversified Fishery  
Products, Andhra Pradesh  
Fisheries Corpn.Ltd.,  
Visakhapatnam-530003.  
Officer-on-Special Duty,  
Andhra Pradesh Fisheries  
Corporation Ltd.,  
7-6-17, Club Road,  
Waltair Uplands,  
Visakhapatnam 530003.
10. Dr.P.Lakshmana Perumal  
Swamy,  
Lecturer in Microbiology,  
Dept. of Marine Sciences,  
University of Cochin,  
Cochin 682016  
The Head,  
Dept. of Marine Sciences,  
University of Cochin,  
Cochin 682016.
11. Sh. K.Laxman,  
Asst. Director of Fisheries,  
(Tech.)  
Fisheries Training Institute,  
Kakinada-533002.  
The Director of Fisheries,  
Andhra Pradesh,  
Hyderabad.
12. Sh. V.Muraleedharan,  
Scientist S1,  
Calicut Research Centre of  
CIFT, West Hill,  
Calicut-5.  
The Director,  
CIFT, Cochin-29.
13. Shri D.V.Nakhwa,  
Quality Supervisor,  
MPEDA Regional Office,  
Apartment No.1102, 11th Floor,  
Prasad Chambers, Tata Road No.2,  
Bombay 400004.  
The Director,  
M.P.E.D.A.,  
Cochin 682016
14. Smt.A.Pushpa,  
Asst. Professor,  
Sri Avinashilingam Home  
Science College,  
Coimbatore-43  
The Principal,  
Sri Avinashilingam  
Home Science College,  
Coimbatore 43.
15. Sri P.Puttarajappa,  
Scientist 'A',  
CFTRI, Mysore 570013  
The Director,  
CFTRI, Mysore 570013.
16. Sh. K.N. Prasad,  
Sr. Research Assistant,  
Fisheries Dept.,  
Govt of Gujarat,  
Port Okha 361350  
The Commissioner of  
Fisheries,  
New Mental Hospital,  
Building,  
Ahmedabad-16
17. Sh. R.R.Pathak,  
Sr. Research Asst.,  
Dept.of Fisheries, Gujarat,  
Port Okha 361350  
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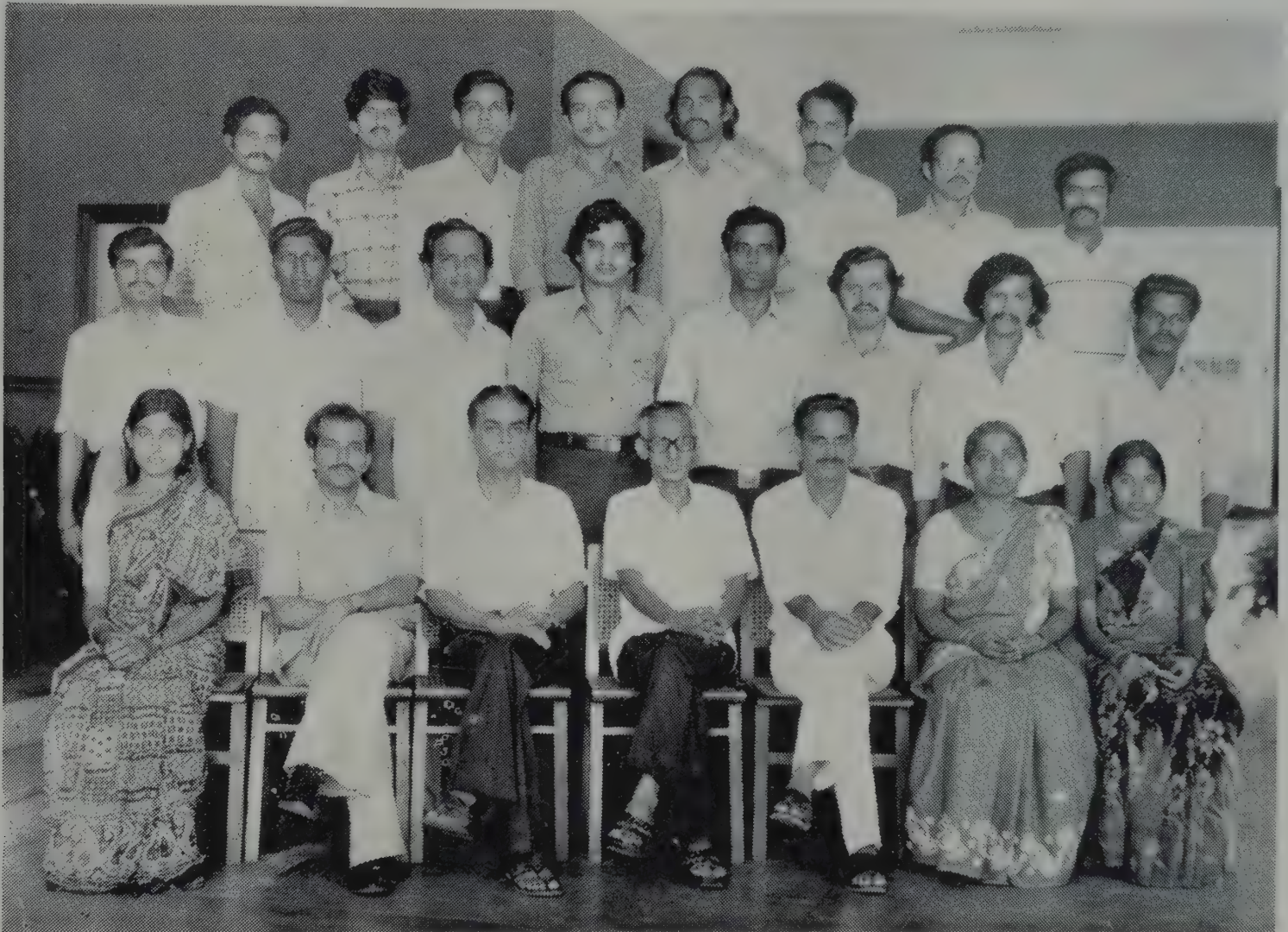
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| 18. Sh. Rup Sankar Chakraborty,<br>Scientist S1,<br>Kakinada Research Centre<br>of CIFT,<br>D No. 1-14-7,<br>Sreeram Nagar,<br>Kakinada-3 (A.P.) | The Director,<br>CIFT,<br>Cochin-682029   |
| 19. Sh. S. Ravindran Nair,<br>Research Assistant,<br>Regional Shrimp Hatchery,<br>Azhikode Jetty, Eriyad P.O.,<br>Trichur Dist.                  | The Director of<br>Fisheries,<br>Kerala,<br>Trivandrum  |
| 20. Sh. P. M. Sherief,<br>Asst. Professor,<br>College of Fisheries,<br>Mannuthy 680651   | The Dean,<br>College of Fisheries,<br>Kerala Agricultural<br>University,<br>Mannuthy 680651,<br>Trichur Dist. |

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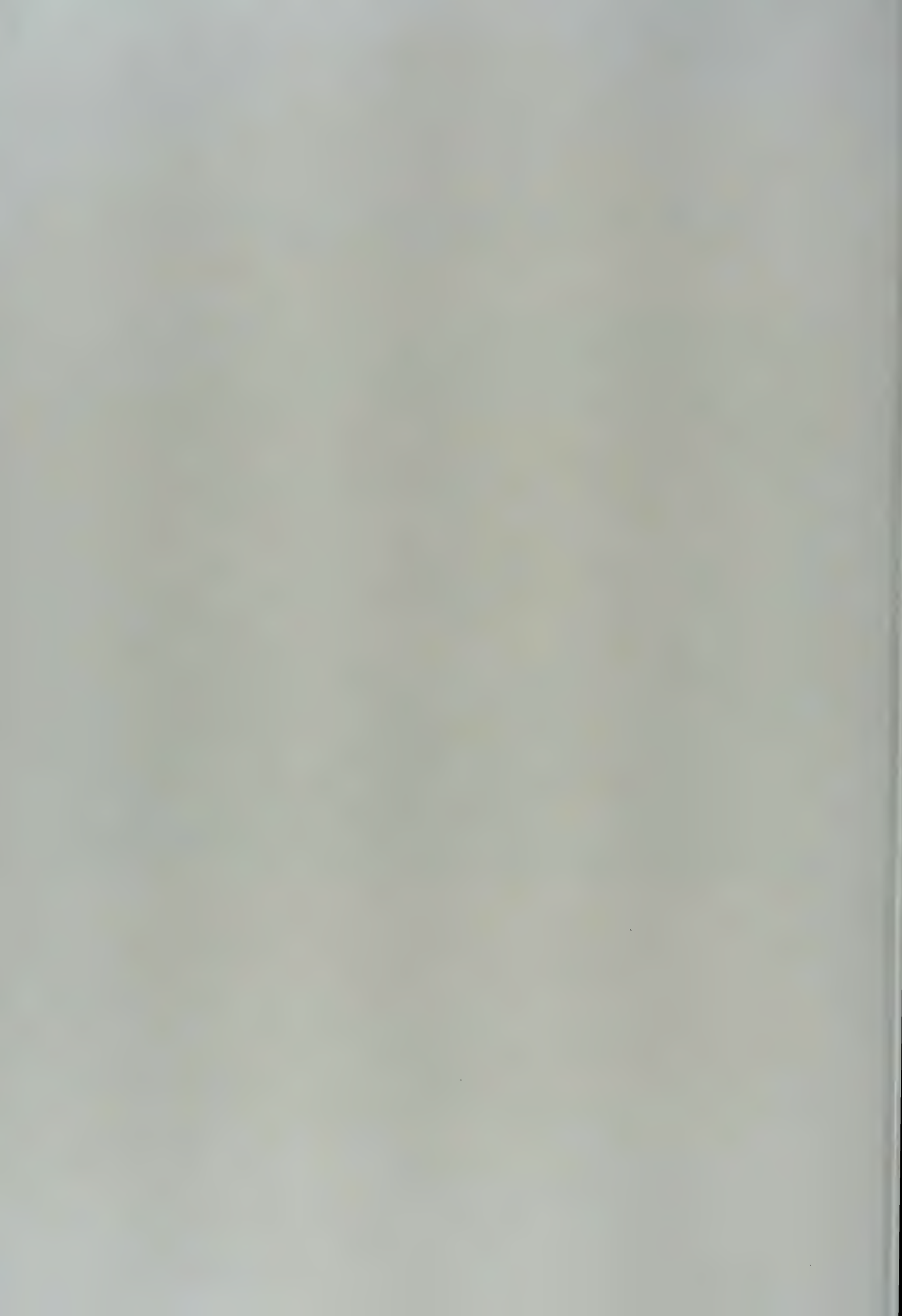
## MEMBERS OF ACADEMIC COUNCIL AND PARTICIPANTS OF THE SUMMER INSTITUTE



*Sitting* (L to R) Miss. V. Bhuvaneswari, S/Shri K. G, Ramachandran Nair, P. Madhavan, M. R. Nair, (Director), Dr. K. Gopakumar, Mrs. B. Ambika Nair, Miss. A. Pushpa.

*Standing 1st Row* (L to R) Dr. P. Lakshmana Perumal Swamy, S / Shri P. Puttarajappa, S. Dhananjaya, C. Aswathanarayana, Ansuman Hajra, M. Haridas Bhandary, Dr. M. C. George, Shri S. Ravindran Nair.

*Standing 2nd Row* (L to R) S/Shri D. Nakhwa, K. Laxman, K. N. Prasad, R. R. Pathak, P. M. Sherief, Rup Sankar Chakraborty, V. Muraleedharan, M. Kingsley Laine.



## PROCEEDINGS OF THE SUMMER INSTITUTE

Of the 21 Summer Institutes sanctioned by the ICAR in various disciplines of Agricultural Sciences during the Summer of 1981, this Summer Institute in Non-Traditional Diversified Fish Products And By Products was allotted to the Central Institute of Fisheries Technology, Cochin recognising the significant contributions made by the Institute in the development and transfer of this technology. The academic Council of the Summer Institute has drawn up the syllabi to cover all the newer techniques evolved by the Institute and the schedule of work accordingly prepared allotting proportionate hours both for theory and practical classes. By this in-service training it was hoped that the participants of the Summer Institute would equip themselves with the latest technological advances in the subject and receive the necessary orientation so that when they get back they would be in a position to project their work in the problems in their respective field. Besides the Director of the Summer Institute and three academic members, 9 staff members were appointed to handle theory and practical classes.

20 participants were selected out of 38 eligible applicants. The Summer Institute was inaugurated on 27th April 1981 at 10.30 A.M. by Shri S.N.Rao, Director, Marine Products Export Development Authority, Cochin, and Dr.C.T.Samuel, Professor and Head of Department of Industrial Fisheries, University of Cochin presided over the function. In his inaugural address, Shri S.N.Rao said that the supply of raw materials to the fish processing industry has been so far from the conventional resources and there is urgent need to diversify our fishing effort. The economic viability of deep sea fishing projects is

yet to be proved. However, in the matter of developing processing technology for utilisation of all the resources available in our waters this country has achieved very good progress. He hoped that the participants would find the course very useful at CIET which has developed processing techniques not only for fishery products meant for human consumption but also developed methods of utilising fishery waste from processing plant and non edible material from the sea for industrial purposes. Dr.C.T.Samuel, in his presidential address highlighted the requirements for establishing a market for new or non traditional fish products like modern techniques of production management, economics of production and marketing and marketing techniques.

Altogether 15 lectures of 1½ hours duration were arranged on various subjects relating to non traditional and traditional fishery products. These include topics like fish protein concentrate, fish hydrolysate, paste fishery products, ready- to serve fish based preparations, fish pickles, canning of clams and mussels, chitosan, shark fins, animal feed etc. Two subject matter specialists viz. Shri U.S.Kini, Managing Director, Kodyal Foods and Fats(Pvt.) Ltd, Mangalore and Dr.T.M.Rudra Setty, Professor(Fish Processing), Fisheries College, Mangalore were invited to deliver the guest lectures on 'Prospects of Fish Meal and Fish Oil Industry in India' and 'Manufacture of fish sausage' respectively which stimulated very good interest in the participants. Facilities for practical classes were so provided that every individual participant could gain first hand training in the production technology of various fishery products/by products developed at the Institute. Particular mention has to be made on the practical training the participants received on the operation and working of the pilot plant for production of chitosan from prawn shell waste.

Books and Summer Institute course material were distributed to the participants. Due emphasis was given to group discussions and library work. Films on fish processing and other aspects of fisheries development were screened regularly for the benefit of the participants. For on the spot studies to gain first hand information on the subjects, field trips were arranged. The participants were taken to two fish processing plants, M/s.Karthika Marine and Chemmeens at Cochin. They were also taken around fishing villages at Kannamali and Fort Cochin and also the fishery harbour at Cochin. They visited the fish farm and field laboratory and Krishi Vigyan Kendra of the C.M.F.R.I. located at Narakkal and also the Regional Shrimp hatchery and Fish Meal factory at Azhikode.

Two evaluation Tests were conducted on 8th May and 25th May.

The valedictory function of the Summer Institute was held in the forenoon of 26th May 1981 in the Conference Hall of CIF. The function was presided over by Dr.K.I.Vasu, Pro-vice Chancellor, University of Cochin. Shri M.Devidas Menon, Fisheries Consultant and former Director of Integrated Fisheries Project, Cochin gave the valedictory address. The President distributed the course certificates to the participants.

The 20 participants of Summer Institute comprised of 6 Officials from State Fisheries Departments (Andhra Pradesh, Gujarat, Karnataka, Kerala and Tamil Nadu), 1 from State Fisheries Development Corporation(Andhra Pradesh), 4 from Agricultural Universities(Fisheries College, Mangalore under University of Agricultural Science, Bangalore and Fisheries College, Mannuthy, under Kerala Agricultural University). 1 from Central Food Technological Research Institute, Mysore, 1 from Food Craft Institute, 2 from Home Science College, 1 from University

Department (Department of Marine Sciences, University of Cochin), 1 from Marine Products Export Development Authority and 3 from ICAR Fisheries Institutes (CIFRI and CIET). They were drawn from seven coastal states of India representing 14 institutions.

The Summer Institute was evaluated on an ex-post-facto design by using two techniques. The coverage-utility index (CUI) and the 'Summer Institute Efficiency Index (SIEI) were specially prepared for evaluation and comparison methods. As per the values obtained by the evaluation methodologies, the Summer Institute was found to be effective to a large extent in attaining the objectives. Based on the value of 't' test, it was noted that the participants irrespective of their age, education and attendance in previous Summer Institutes perceived the programme to be effective. Almost all the participants indicated a correct reason to participate, were satisfied with the season, duration and theory-practical ratio of the Summer Institute and felt the programme to be quite comfortable. The participants co-operated well and evinced keen interest during the entire course on which due appreciation has been recorded. It was evident that with the updated knowledge gained by the participants during the training, they were better equipped to undertake practical work in the field of Non Traditional Diversified Fish Products and By Products.

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# STATUS OF DIVERSIFIED PRODUCTS IN FISH PROCESSING INDUSTRY

M.R. Nair

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## INTRODUCTION

India is blessed with a very long coast line. It has a continental shelf of 57.9 million hectares excluding that around oceanic islands. Of this, an average only 5% is intensively exploited and another nearly 15% marginally exploited. Declaration of the 200 mile exclusive economic zone has thrown open another vast area for exploration and exploitation. The inland water spreads covering several rivers, rivulets, reservoirs and lakes constitute another source for sustained fish yield. The recent successful introduction of aquaculture including mariculture for several species of fish and shell fish holds the promise of added aquatic productivity. Ranking 7th in the world in magnitude of production and landing 2.4 million metric tonnes of fish, India's exports of processed marine products touched an all time high record of 92184 tonnes netting a foreign exchange earning of Rs. 2620 millions in 1979.

## UTILIZATION

Until late fifties the disposal of fish catch used to comprise around 50% for fresh consumption, 25% sun dried, 20% salted, the balance being converted as manure. The only

processing technique known was that of salting/curing and sun drying of certain species of fish and prawn practised in a rather primitive manner. However, even this primitive knowledge supported the processing and export of sizeable quantities of dry prawn pulp. It was the collapse of these traditional markets for dry prawn pulp at the close of the World War II which in fact paved the way for the birth of the modern seafood processing industry of India. This together with other developments in the sphere of disposal of fish like provision of a net work of motorable roads connecting the landing sites with the interior, establishment of ice plants at or near the landing centres, employment of trucks for transportation of fish, development of containers for fish etc. adequately supported by evolution of the necessary technological base by research and development activities in the country resulted in a change in the pattern of disposal of fish as follows: Consumption in fresh form - 69%, frozen - 3%, canned - 0.2%, dried/cured - 19% and reduction and other miscellaneous purposes - 8.8%.

#### EXPORTS

A break-up of the commodities exported in 1979 reveals that over 58% in quantity and 85% in value is contributed by a single item viz. prawns which hardly contribute 10% of the total marine landings in the country. Whereas the country has an installed capacity for freezing 1250 tonnes of sea foods per day, that the export of frozen foods was

only 83,492 tonnes in 1979 is a pointer towards the high degree of under utilisation of the capacity. The picture on the canning front is still worse. India exported 139 tonnes of canned sea foods, mostly prawn in 1979 against a production capacity of 250 tonnes per day.

A salvage from this state of affairs can be found only in diversification of the products. With a steady market existing for frozen and canned prawns, the industry had in the past, been reluctant to diversify, first because the fate of the new commodity in the international market was uncertain and second, because the technology of production of many products which could have had a market within the country and abroad, was not available. However, with agents like Marine Products Export Development Authority undertaking promotional activities and significant contribution made by research and development organisations, particularly CIFT, in the development of new products, there has been a greater awareness towards the need for diversification for the very sustenance and any probable future expansion of the Indian Seafood processing industry.

For the development of an export market, the strongest support is to be provided by a properly organised domestic market, which unfortunately, is the missing part in Indian seafood industry. Our country is passing through a phase of rapid industrialisation which will result in urbanisation of several parts of the country. This will necessarily add

an impetus to the popularisation of processed convenient foods, which means, if properly exploited, processed sea foods can find a ready market within the country as well which will significantly increase the importance of and need for diversification in processed fishery products to meet the internal demand.

#### Scope for product diversification

Frozen fish fillets in consumer packs are very popular in several countries. The technique of hand filleting of some species of fish giving maximum fillet yield has been perfected and from a study of the freezing and storage characteristics, the methodology as applied to fishes like synagris, cat fish, sciaenids has been evolved and products so prepared have already met with demand from domestic as well as foreign markets. Pomfret, seer, sole, ribbon fish, eel, perch, tilapia etc. when quick frozen in different forms like whole, round, fillet etc. can have potential export market. Similarly frozen squid and cuttle fish have already established themselves as commodities for export. Technical know-how has also been worked out for freezing both the raw and pre-cooked meats of crabs, mussels and clams in glazed blocks. The idle capacity in our freezing plants can profitably be utilised for preserving these fishes, shell fishes both for export and internal distribution. Besides enabling the industry to run on more economic lines, this step ensures better distribution of our fishery resources season-wise and area-wise so

that a wide cross section of the population is benefitted. It is heartening to note that export of frozen fish other than prawns has shown a remarkable progress from 0.02% in 1970 to 26.17% of total exports in 1979, though value-wise its contribution was only 4.4%.

### Canning

Though started initially with prawns, with an export bias for achieving a peak export worth Rs.5.24 crores in 1973, of late, the demand for this commodity has gone down considerably in the world market. This crisis has been precipitated by several reasons like lack of demand from world market, high cost of production caused by the imported tin container and the demand for raw prawns of all size grades from the freezing industry which offered higher prices for this commodity. Barring some small quantities of oil sardine and mackerel being canned for internal markets and defence supplies, our entire installed processing capacity lies idle which could be advantageously make use of for processing our wider variety of other fishes and shell fishes. We have now readily at hand the know-how for canning of tuna, seer, silver and black pomfret, hilsa, lactarius, tilapia, polynemus and smoked eel. Technology has been evolved for canning sardine in different forms like 'natural style' which dispenses with the use of filling medium and thus reduce the cost of production, in oil and in sauces. Methods have also been worked out for canning of our important

shell fishes like clams, muscles, crabs, oysters and also the cephalopod, squid, canned 'prawn with peas', tuna in flavoured oil as well as with onion and peas are some of the novel items. All these types of canned products can find good demand both in the internal market and abroad especially as they do not require any cold chain for transportation and distribution like frozen and iced fish. It is also possible to organise a 'home canning' set up to utilise any surplus fish for processing into canned products.

#### Dried, smoked and pickled products

Improved methods for dry curing and sun drying which can produce products of extended shelf life and good consumer preference are now available. Smoked fish is a delicacy for which taste is yet to be developed. Smoking as a method of preservation is quite suited to oil sardines, a fish which cannot be preserved by drying due to the development of rancidity. Oil sardines subjected to 'Meditarranean salting' could be further canned in a special style and is considered as a delicacy in several consuming countries. Methods are available for the production of a delicatessen product light smoked dried mussel meat. Methods have also been perfected for preparing pickles from less utilised shell fishes like clam, mussels and oysters.

### Miscellaneous products

Small varieties of miscellaneous fishes as well as some larger types which are not popular as fresh fish command very poor demand from fresh fish markets. Methods have been worked out to convert them into edible products. A colourless and odourless fish protein concentrate in dry powder form can be prepared from such fishes, suitable for being incorporated with wheat flour in the preparation of chapathis, bread, biscuit and host of other preparations. A bacteriological peptone suitable for microbiological culture studies and even superior in performance to the best imported brand of the material in promotion and growth of microorganisms has been developed from some of these varieties of fishes. Similarly edible meat picked from the mixed varieties of cheap fishes free of skin and bones with the help of a machine and frozen in blocks as 'fish kheema' has been found to be very popular as a cutlet base as well as for incorporation in several products, like fish soup powder, fish wafers, fish spirals, fish jams, fish sausages, pet foods etc. either as such or after partial hydrolysis and deodourisation.

Trash fishes as well as offal from fish processing factories can be easily converted into fish meal for poultry and cattle feed by boiling, pressing, drying and pulverising. Both offal and trash fishes can be minced and ensiled by lactic acid fermentation and the fish ensilage so prepared could keep in good condition at atmospheric condition and can

be fed to cattle etc. either as such after neutralising the acid or after converting into a dry feed mix incorporating rice bran, tapiocca powder, sea weed powder etc. and drying.

### Shark fins and fish oil

Among the conventional fish products dry shark fins still find a good export market for making shark fin soup. As the importing countries extract the rays out of the fins before using them in soup, a simple method has been worked out for separating the rays from the fins which besides facilitating handling and transportation ensures better financial return than by exporting the fins as such. Livers of shark are at present put to maximum use in our country for extracting oil which is a rich natural source of vitamin A and D. The residue left after extracting the oil is now used for poultry feed and live stock feed compounding.

Sardine oil is yet another conventional product which was used only for smearing on country crafts as a preservative in olden days. Recently methods have been developed for scientific extraction of oil and its conversion into several industrial products such as factice (artificial rubber filling compound), paint and printing ink bases and lubricating oil.

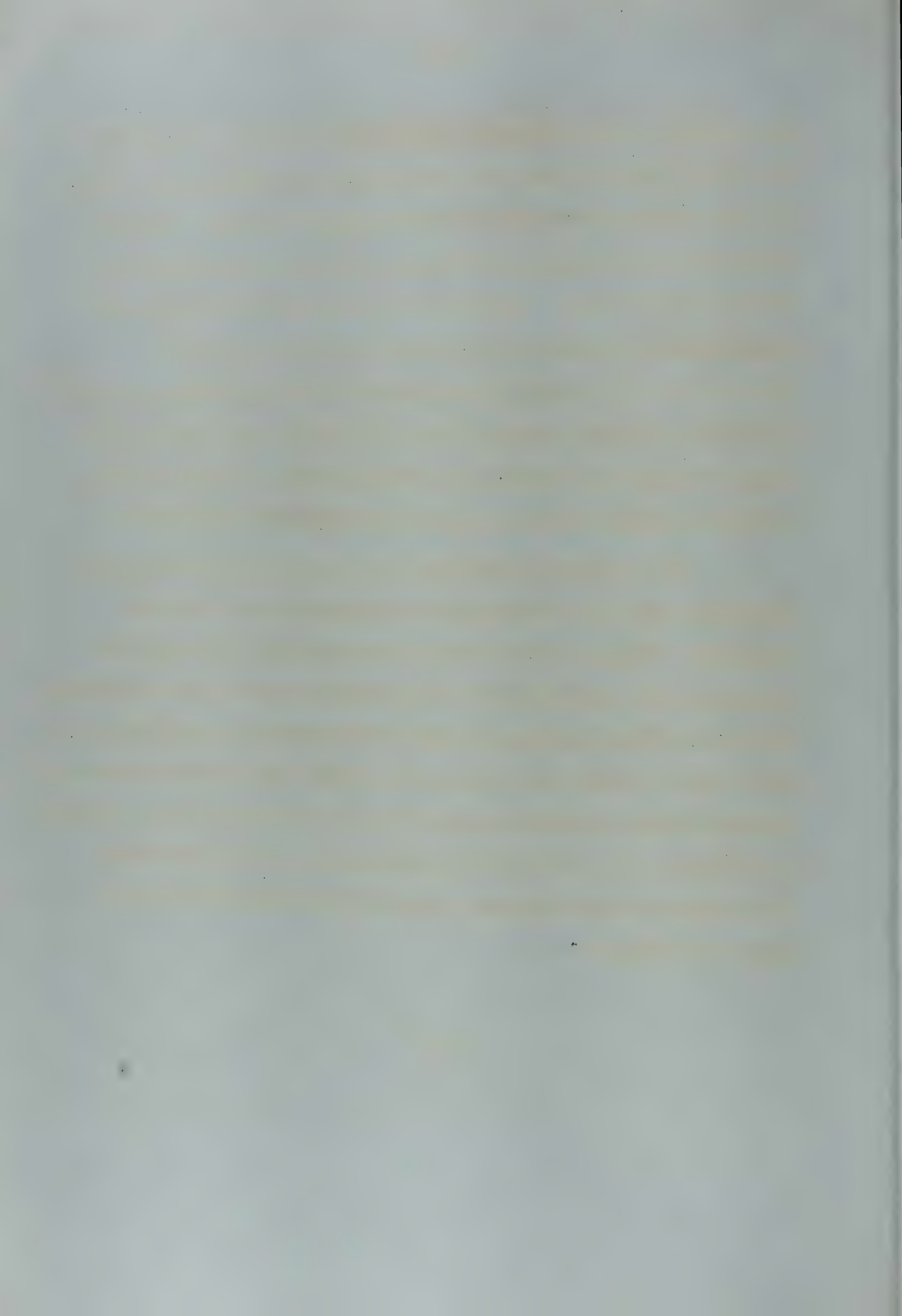
### Utilisation of Processing Waste

Among the ~~non~~-traditional uses of our marine resources, mention may be made of methods worked out recently

for economic utilisation of prawn shell waste. An estimated 40 - 50 thousand tonnes of prawn heads and shells are thrown out from processing factories per annum as waste. A small portion of it is cooked, dried and powdered for manure and poultry/cattle feed. A process has now been developed for preparation of protein concentrate in paste form and conversion of the remaining materials into chitosan, a versatile industrial chemical having wide and varied application like sizing of paper and textiles, clarification of wine, purification of water and as a general industrial flocculant.

The products mentioned are only indicative and not exhaustive and also for which the technology is already available. There is vast scope for expanding the consumer sector in both traditional and non-traditional marine products. Since diversified products could meet consumer preference of a wider cross section of people both inside the country and abroad, simultaneously providing industrial and pharmaceutical products, resorting to the step of diversification of fish products will ensure better and more economic utilisation of our marine resources.

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# BY-PRODUCTS TECHNOLOGY AND WASTE UTILIZATION IN FISHING INDUSTRY

P.V. Prabhu

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## INTRODUCTION

Rapid strides have been made by the fishing and fish processing industry in India during the past three decades with the result that the fish landing has doubled and the export of processed fishery products has gone up by over 300%. However, the modern fish processing industry is mainly based on prawns which constitutes only 10-12% of the marine catches. Considerable progress has been achieved in freezing of prawn and the country now has 217 freezing plants with a total capacity of 1000 tonnes per day. This necessitated the introduction of more and more cold storages and as a result there are altogether 273 cold storages having a total of 21558 tonnes storage capacity. Fish canning industry had also shown rapid progress in the early 1960's but has declined recently and at present only a small percentage of the total catches goes for canning. Major quantities of the fish landings are utilized fresh for consumption while a good percentage is used for salting and curing. Fishery by-products also had an important place in fishery industry all along its development.

PRESENT STATUS OF FISHERY BY-PRODUCTS

India has been producing traditional fishery by-products such as fish meal, fish liver oil, fish fins, fish maws and fish body oil. About 10% of the fish landings are utilized for conversion into fish meal. With the increase in fish landings, the production of fish meal also has increased considerably. The miscellaneous fishes caught along with prawns during trawling form the major source of raw materials for fish meal. They include small jew fish, sole, silver bellies, ribbon fish and the like. Traditional fish meal production was from the sun dried fish collected from various drying centres all along the coast and the product was chiefly used as manure. The better quality fish meal produced has been a prominent item of export from the very beginning of the industry. The importance of improving the quality of fish meal for better use was felt and the Ministry of Food and Agriculture has as early as in 1959 laid specifications regarding the quality of fish meal. Later, the Indian Standards Institution brought out the Indian Standard Specifications (IS:4307-1967) for fish meal as livestock feed for facilitating proper quality control. During recent years the organised fish meal industry has shown signs of fast progress. In 1972 there were seven modern fish meal plants in the country with an installed input capacity of 175 tonnes per day. Few more plants have been installed for the production of fish meal during the past 4 years.

Fish oil industry:

Sharks constitute a considerable proportion of the fish catches of India. The liver oil of sharks found in Indian waters is rich in vitamin A. Apart from a few well organised factories producing vitamin A rich shark liver oil of pharmaceutical quality, there are a number of small extraction units located at several fishing villages. The crude oil extracted in small units is refined and diluted suitably for the production of I.P. grade vitamin A formulations in bigger factories.

Oil sardine happens to be the largest single fishery comprising about 30% of the marine catches of India. The peak season for the fishery is from October to January when the oil content of the fish is also maximum going upto 17%. The traditional method of extracting the oil from the fish was in practice as a cottage industry in the fishing village along the south west coast. The quality of oil extracted in these extraction centres was poor primarily due to the presence of high free fatty acid content and foreign matter and could be used only for painting country fishing crafts. Only recently some organized attempts have been made to produce the oil under controlled conditions employing modern extraction units in the fish meal plants. As a result oil of consistent quality to the extent of about 1500 tonnes is now available for better utilisation.

Shark fin and fish maws:

Amont others dried shark fins and fish maws also are items of marine products export from India. The whole

quantity of dried shark fins and fish maws produced in the country is at present exported to countries like Hongkong, Singapore, Malayasia and United Kingdom. They form the raw materials for production of fin rays, glues, isinglass and gelatin.

#### Prawn shell waste:

Since major portion of prawns landed are being processed into frozen or canned form, large quantities of head and shell waste are now available from the processing plants. In early days the general practice of disposal of this huge quantity was to throw away into the back waters or partly utilize as manure. Presently a good percentage of this waste is sun dried and powdered and used either as manure or in poultry feed formulations. Prawn shell powder generally contains only about 35% protein and as such is not classed along with fish meal.

#### SCOPE FOR FURTHER DEVELOPMENT

With the expected increase of fish landing consequent to the exploitation of the extended 320 km. economic zone for fishing there is wide scope for expanding the by-products industry in the country. The inland fish production is also picking up rapidly with the improved techniques of cultivating fish in reservoirs, ponds and sewage waters. Investigations being conducted in various research institutes on fish processing and utilization have shown promising results for development of fishery by-products as well as speciality products from fish

wastes and by-catches of trawlers.

Fish meal:

About a dozen modern fish meal plants now operating at various fishery centres do not utilize their full installed capacity although they turn out considerable quantities of fish meal. As the fish landings are scattered all along the coast the prospects of installing fish meal plants of large capacity are not very bright. The fish meal production can be enhanced by the introduction of comparatively small plants in the fishing villages. A batch type rotary drum dryer for production of fish meal from whole lean fish or press cake from fish body oil extraction plants has been successfully demonstrated. Designs of such plants which can be fabricated indigenously are obtainable from Central Institute of Fisheries Technology.

The tempo of progress being made in the field of cattle and poultry farming can be maintained and further accelerated only by increasing the production of fish meal which forms an important ingredient in the feed for live stock. The world requirement of fish meal also is increasing and India can expect to partly cater to the needs by stepping up fish meal export. The expected increase in fish landing and the increasing demand in the internal and overseas markets promise a very bright future for the industry.

Fish oil:

Production of fish oil has achieved considerable improvement both in quality and quantity in recent times due

to the establishment of modern fish meal plants. Extensive work on sardine oil has been carried out in Central Institute of Fisheries Technology, Central Food Technological Research Institute and other prominent research organisations in the country and has established wide industrial uses for good quality sardine oil. It has been shown that the oil is rich in polyunsaturated long chain fatty acids.

The work done in the country on the industrial uses of sardine oil such as in paint and allied industry, reported in Paint India (1968), shows a great potential for sardine oil and industries based on it. Although wide fluctuation is observed in the landing of oil sardine, a steady and abundant supply can be predicted with the exploitation of the pelagic fishery resources by the introduction of purse seines and other suitable gear. Even if a good percentage of the catches is likely to go for fresh consumption owing to the improvements effected in the transportation of fresh fish, increasing quantities are also expected to be taken for processing into fish meal and fish oil.

#### Shark skin and fins:

Dried shark fins are now exported as a raw material for making fin rays, glue etc. The fins can be processed for these products within the country. The method for extracting fins rays has been worked out by CIFT and has been taken up by the industry. Fish glue can also be prepared from the fins after extracting the rays.

It has been roughly commuted that about 2 lakh sq.m.

of shark skin can be manufactured in the country. Presently shark skin is not taken for any use. The CIFT and the Central Leather Research Institute have shown that the skin from sharks, especially from bigger varieties can economically be flayed off and processed into superior quality leather. There are excellent prospects for developing the shark skin and fin rays industry which will help to provide employment to rural people and profitably utilize the raw materials which now go as waste.

#### Fish maws:

Fish maws can be processed into finished products such as isinglass and gelatin. The expansion of the fishing activities to the 320 Km. economic zone will result in the increased landing of fishes from which air bladders will be available for developing the industry based on fish maws. The technological aspects have been studied by the various research Institutes and the results of the studies can be exploited by the industry.

#### Utilization of prawn shell and head waste:

It is estimated that 45 to 50 thousand tonnes of prawn head and shell waste is now available from the prawn freezing and canning industry. To put the waste to better use, attempts have been made by the research organisations working out suitable methods for production of new products having food value or industrial importance. The work done in CIFT in this field is worth mentioning. Methods have been worked out for the extraction of protein and chitin and for the conversion

of chitin into chitosan. Extensive work has also been done on the industrial application of chitosan.

Methods for the production of yet another industrially important product, glucosamine hydrochloride, from prawn waste have been developed by CIFT and National Chemical Laboratory, Poona.

The chances of starting new industries to process the abundantly available prawn waste and squilla are enhanced by these researches as well as by the needs of the prawn processing industry to earn wealth from the waste.

Squilla (*Orato squilla nepa*), which form a considerable portion of the trawler catch has also been shown a rich source of chitin. A method for separating the protein from squilla has also been reported.

There are immense possibilities of utilising the trawler by-batches for production of a number of diversified products, processes for which have been developed in various research laboratories. However, an organised attempt is called for to exploit these processes commercially and expand the industry.

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TECHNOLOGY OF PRODUCTION OF MINCED FISH MEAT  
FROM LOW COST FISH AND ITS STORAGE CHARACTERISTICS

P.A. Perigreen

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Large quantities of inexpensive varieties of fish are caught from Indian waters. At present these varieties of fish are not properly utilised. They are either thrown back into the sea or converted into fish meal. The landing of these inexpensive varieties of fish will increase considerably in the near future with the introduction of more bigger mechanised fishing vessels. One of the methods of utilizing these cheap varieties of fish is the production of minced meat which can be used as a base material for the production of a number of processed fishery products. The fishes which can be used for this purpose include sciaenids, threadfin bream, ribbon fish, cat fish, soles, saurida, horse mackerel etc. The meat is separated from the fish using meat bone separator or meat picking machine.

Equipment

The principle behind the meat separation is the squeezing and tearing action of a flexible belt moving against the outside of a rotating perforated stainless steel drum. The softer and less cohesive flesh is forced through the perforation of the drum by pressure developed between the drum

and the belt rotating in the same direction but at different speeds. Skin and bones remain behind on the belt.

A meat strainer is provided in some machines for the second stage removal of fine bone particles. The meat picking machines are now available in India.

#### Method of production

1. Use very fresh fish for the production of minced meat. Raw material should be sorted before processing. Any damaged, contaminated or otherwise unacceptable fish should be discarded.
2. Wash the fish thoroughly in potable water to remove dirt. Keep the fish at low temperature.
3. Remove head, viscera and wash thoroughly. If necessary the fish should be descaled since scales of some fishes are not easy to separate mechanically.
4. Split the fish in half (depending on size). The backbone of large fishes should be partially removed as the backbone above the belly cavity is unsuitable for processing as it contains large sharp bones which may damage the belt of the separator. Wash and feed into the meat picking machine or meat bone separator. The separator should be fed continuously but not excessively. Split fish should be fed to the separator so that the cut surface contacts the perforated surface.

5. Remove the separated meat from the machine and wash if necessary.

Similarly the meat adhering to the bones after filleting of fish can also be separated using the meat picking machine.

### Yield

The yield of minced meat from different varieties of fish are given below:

<u>Name of fish</u>	<u>% yield of minced meat</u>
Silver bellies	40
Ribbon fish	50
Cat fish	34
Sciaenids	50
Sharks	29
Rays	39
Soles (medium & large)	57
Anchoviella	38
Horse mackerel	43

From the above it is seen that the yield of picked meat varies with the species of fish.

The yield of picked meat obtainable from filleting waste of some common fishes are given below:

<u>Name of fish</u>	<u>Yield of picked meat from filleting waste (% of whole fish)</u>
Cat fish	9 - 10
Indian halibut	7 - 8
Seer fish	6 - 7
Perch	6
Kalava	6 - 7
Milk fish	7 - 8

### Quality of picked meat

The picked meat processed as above will sometimes be discoloured due to the presence of blood pigments. This discolouration can be overcome by washing the picked meat with ice cold water. But washing reduces the yield of picked meat as a result of the removal of water soluble constituents and affects the taste and flavour of the product adversely. Picked meat from sharks and rays has to be washed in chilled brine first and then with chilled water several times to remove urea. The repeated washing gives a bland and flavourless product.

### Bacteriological quality

The mechanically separated meat can have high bacterial loads if the fish waste or small varieties of fish are not kept properly chilled and hygienically stored. When strict limitations on time, temperature and storage conditions are rigorously followed, bacteriological quality of mechanically separated fish meat compares very well with that of hand deboned meat. The mechanically separated meat will have to be immediately chilled to prevent multiplication of bacteria and strict quality control measures will have to be adopted to get a product of good quality.

### Blending of minced meat

Minced fish flesh may be blended with food additives in order to retain functional properties essential to the final product. Binder solutions are in binding fish particles

together giving a smooth, moist and cohesive texture. The commonly used additives in minced fish are salt, sugar, monosodium glutamate, sodium tripolyphosphate and soluble starch. Antioxidants may be added to prevent fat oxidation. Natural spices protect the minced fish during storage and acts as flavouring agents.

#### Freezing of minced fish meat

The minced meat is commonly frozen as blocks of  $\frac{1}{2}$  kg or 1 kg. The material is packed in polythene lined waxed cartons and frozen at  $-35$  to  $-40^{\circ}\text{C}$  in contact plate freezer or blast freezer. The frozen blocks of minced meat are packed in corrugated fibre board cartons and stored at  $-23^{\circ}\text{C}$  or below.

#### Changes during frozen storage

1. As a result of protein denaturation during freezing and cold storage, the product will lose its water-binding and fat emulsifying capacity and develops a tough and/or spongy texture. Such meat will not be suitable for using as raw material for products like fish sausage when elasticity is the prime factor.

In frozen stored minced meat thawing drip losses are considerable if proper treatments are not applied to the meat. The drip carries with it large amounts of water soluble components which will affect the taste of the product adversely. The mincing process mixes the fatty layers of the

body into the mince and results in exposure of the fat particles to air during the mincing operation. The blood pigments present in the dark meat of the fish will also catalyse the oxidation reactions. Thus during storage, in general, oxidative changes will be faster in minced fish meat compared to the intact muscle. Desiccation and oxidative changes will be maximum if the frozen minced meat is not well protected by proper packaging.

#### Utilisation of minced fish meat

Minced fish meat is used as a base material for the production of fish sausage, fish fingers, cutlets, cakes, paste, fish balls, minced salted fish, fish flakes, fish hydrolysates etc.

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Technology of production of fish soup powder  
and fish wafers

K.Gopakumar

FISH SOUP POWDER

Fish soup powder or soup tablets are popular in many parts of the world. These products generally contain hydrolysed proteins, fat and several ingredients including seasonings. Soup powder can be prepared out of fishmeat and the major steps in the manufacture are given below:

<u>Recipe</u>	<u>Weight in grams</u>
Cooked fishmeat	100 g
salt (NaCl)	26.6
Hydrogenated Vegetable at	17.7
Sliced onions	166.0
Corriander powder	2.2
Starch (Tapioca)	44.2
Skim milk powder	17.7
Glucose	8.8
Pepper powder	2.2
Ascorbic acid	0.22
Sodium Carboxymethyl Cellulose (CMC)	0.44
Monosodium glutamate (MSG)	1.32

1. Preparation of the material

Dress the fish free of head, viscera and scales. Cook the fish. Separate the meat out of the cooked fish. Gently press the fish meat in a cloth or canvas to remove excess water.

## 2. Incorporation of the ingredients

Fry the onions and corriander powder in the vegetable fat until the onions turn dapp/yellow to brown in colour. Add all other solid items like starch, spices etc. and mix thoroughly. Cool to room temperature.

## 3. Grinding

First grind the cooked fish meat with equal quantity of water in wet soak food grinder mechanically for one hour. Add the fried onions etc to this mix and continue grinding for an additional half an hour to a very fine paste. Ascorbic acid and CMC are added and the grinding continued for one or two minutes.

## 4. Drying

Pour the paste into aluminium trays to about 1 to 2 cm thickness and dry it under vacuum or under sun. Vacuum drying gives a white colour to the soup.

## Powdering

The dried soup cakes are pulverised in a blender to a very fine powder. Mix milk powder at this stage with the soup powder. Pack the finished soup powder in air tight containers,

## Preparation of soup

The soup can be prepared by boiling one part of the powder in 20 parts of water for five minutes.

Shelf life at room temperature - One year

## FISH FLAKES

### Composition of ingredients

Cooked fish meat (free of bones and skin)	2 kg.
Corn flour	1 kg.
Tapioca starch	2 kg.
Common salt (NaCl)	50 g
Water	3.5 ltrs.

Method of preparation

Hemogenise the cooked fish meat with one litre of water for half an hour in a mechanical grinder like the wet food grinder. Add starch, salt and the rest of the water and continue the grinding for another one hour or more until a very fine paste is obtained. Desired Food colours can be added at the final stage of grinding to impart colours to the flakes.

Spread the hemoginised mass uniformly in aluminium trays in thin layers of 1-3 mm thickness and cook under steam for 10-15 minutes. This cooking process impart transparency to the flakes. Cool to room temperature. Cut the cooked layers into desired shapes and dry under sun or in an artificial electric dryer (maintained at about 50°C) to moisture level of less than six percent.

The dried flakes can be packed in polythene bags or paper packets. When fried in hot vegetable oil the flake swells and become very crisp. The flakes can have a shelf life over 2 years at ambient temperatures.

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## Production Techniques of fish hydrolysates

K. Gopakumar

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Protein hydrolysates have attained an important place in the realm of man's protein fortified foods and beverages. This has mainly been due to their high solubility and digestibility. The comparatively easily commercial production techniques for protein hydrolysates also find easy commercial viability compared to many other industrial processing techniques. A variety of methods of production techniques are available. The most common among them are listed below:

### Acid hydrolysis:

The whole fish is cleaned well to be free of slime and adhering dirt. They are then comminuted in a mechanical meatmincer. The minced fish meat is then cooked well with 2 to 6 N acid containing water and maintained at about 90 - 100°C for 12-24 hours to get a completely soluble finished product. The major disadvantage of this process is that the final finished product, protein hydrolysate, will be acidic and has to be ~~menx~~ neutralised by alkalies to bring the pH to 7. This step invariably introduces large quantities of salt in the hydrolysates. Apart from this another major disadvantage is the loss of some acid labile amino acids. This results loss in nutritive value.

### Enzymatic hydrolysis

In most industrial processes of production of protein hydrolysis, a number of enzymes are used. The enzymatic production of protein hydrolysates is perhaps the most convenient and cheapest technique. The process is fast and gives hydrolysates without much loss in most essential amino acids. However, a suitable enzyme has

to be selected for this process. The choice of this depends on factors like stability, cost etc. The important commercially available proteolytic enzymes are papain, pepsin, bromolein, ficin and trypsin. Most protein hydrolysates are highly bitter in taste. Hence, flavouring agents like cocoa are usually used during their fortification in food preparation to mask the bitter taste.

Among the important proteolytic enzymes listed above the most widely used ones are bromolein and papain. The industrial methods of production of protein hydrolysates using bromolein and papain are given below:

#### Hydrolysis with bromolein

##### (i) Preparation of enzyme

Commercially available enzyme is dissolved in 100 parts of citrate buffer of pH 6. It is then centrifuged and the supernatant is taken. This is the stock enzyme solution for hydrolysis. This<sup>is</sup>/stable, if kept at 3 to 5°C, for a week.

##### (ii) Preparation of water fat emulsion:

Ten parts of hydrogenated fat, antioxidant (BHA or BHT, 0.0%) and 0.15 part of sorbitan monostearate (emulsifier) are mixed together and heated to 65°C for about 10 to 15 minutes. To this water, containing 0.35 part sorbitan monostearate, is added (90 parts) and the whole mixture is homogenised in a waring blender and then kept overnight. Next day the soluble oil - water emulsion is separated from the excess fat and taken separately.

##### (iii) Hydrolysis

Take 100 parts minced fish meat, 20 parts water and 80 parts oil water emulsion and homogenised in a blunder for 5 minutes. To the resulting pasty mass add the enzyme stock solution (six parts by weight) and transfer the whole mass into a reaction vessel maintained

at 57°C. The hydrolysis is continued for 15 minutes with continuous stirring. After the reaction is over the mixture is heated to 80°C for 12 minutes to deactivate the enzyme. The whole mass is again homogenised in a blender and then rapidly cooled to 5°C. The resulting fish hydrolysate is dried in a spray drier to get a fine powder.

#### Hydrolysis with Papain

##### Enzyme stock solution

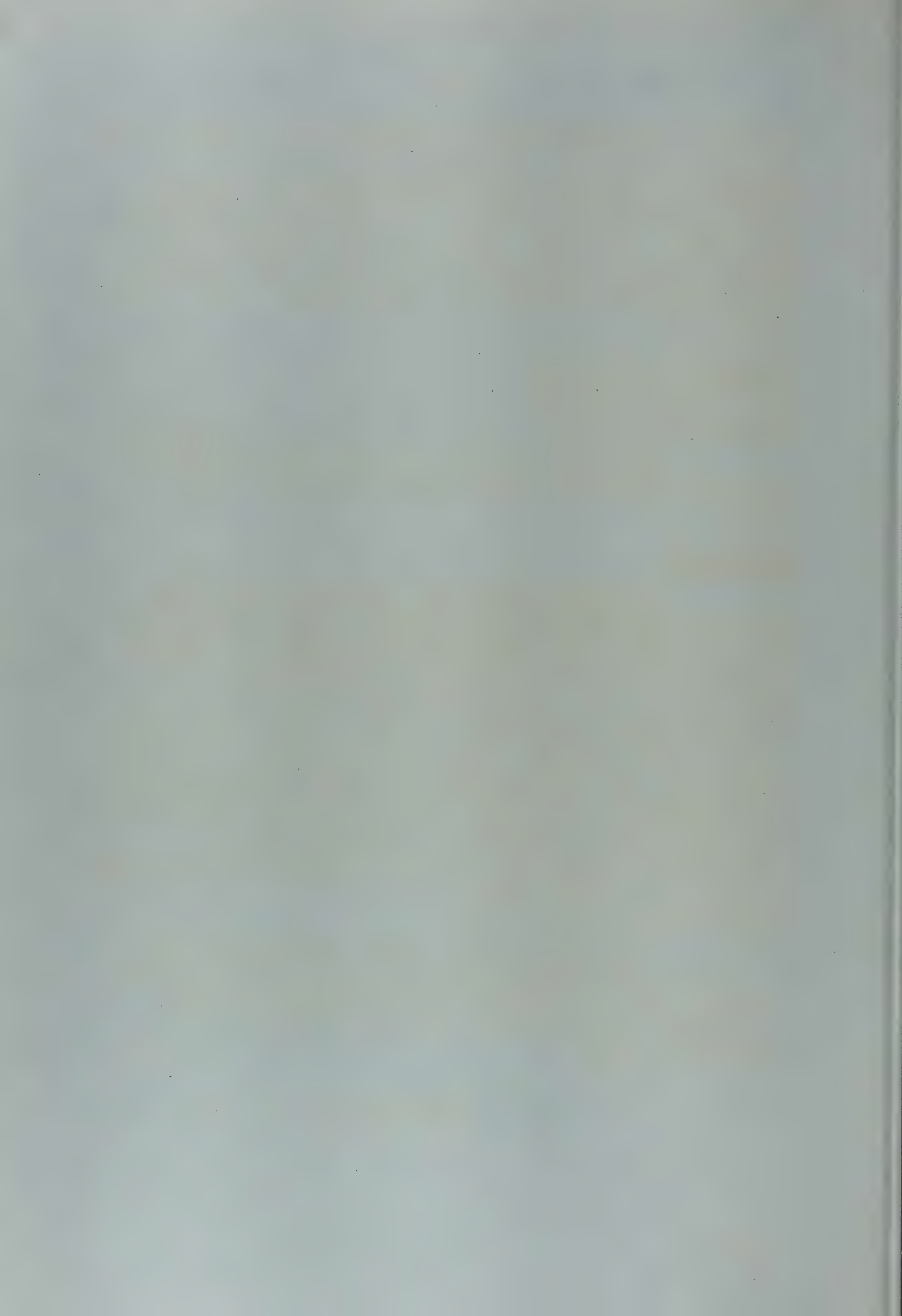
About 25 g of the enzyme is taken in 100 ml distilled water and centrifuged. The clear filtrate is taken.

##### Hydrolysis

Comminuted fish meat is cooked with water (1:1 W/V) and this process results in the sterilisation of the mixture also. The pH of the mixture is adjusted with acids to 6.5. The mixture is transferred to a reaction vessel maintained at 55°C and the enzyme is added to this mixture (1:30, enzyme nitrogen to protein nitrogen). The whole mixture is stirred vigorously and the hydrolysis is continued for half an hour by the time the hydrolysis is completed. The hydrolysate is filtered, concentrated and dried in vacuum to get a fine highly hygroscopic powder.

This hydrolysate can be incorporated in a variety of food preparations like soups, beverages etc. to enhance their protein content and thereby their nutritive value.

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# FISH PROTEIN CONCENTRATE - PRODUCTION, PROBLEMS AND PROSPECTS

K.Gopakumar

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Fish has been an important source of animal protein for man from time immemorial. However, its preservation and storage have posed tremendous problems for him. Dry fish for long remained as the best way of preserving and storage of fish until the advent of modern methods of preservation like canning, freezing, freeze drying etc. Fish protein concentrate was developed to solve these problems. History records that the fish protein concentrate was first prepared by the Romans. The first successful attempt of recent times to prepare a stable fish meal, suitable for human consumption, was made by G.M. Dreosti of South Africa in 1937. Subsequently a number of laboratories around the world developed a variety of processes suitable for preparation of a good quality F.P.C.

The Protein Advisory Group (PAG) of the United Nations have recently examined all these processes thoroughly and they defined fish protein concentrate as follows:

" Fish Protein Concentrate (F.P.C.) is a stable product suitable for human consumption, prepared from whole fish or other aquatic animals or parts thereof. Protein concentration is increased by removal of water and in certain cases, of oil, bones and other materials. Traditionally dried or other traditionally preserved products do not fall within this definition".

Most of the well known processes employ a solvent or mixture of solvents for the production of fish protein concentrate. The use of the solvent is to remove fat and other fatty materials responsible for the development of off flavour usually associated with dried fish products. Some of the important processes are described below:

#### The Viobin Process:

This process was developed by Levin in 1964. In this method raw fish is mechanically ground into small pieces. The pieces are then suspended in ethylene dichloride and cooked to boiling by indirect steam. Ethylene dichloride (B.P. 181°F) forms an azeotropic solvent system with water (B.P. 212°F) present in the fish meal. The azeotropic solvent system of ethylene dichloride and water has a low boiling point, 160°F compared to the two solvents - water and ethylene dichloride. The azeotropic distillation removes water in vapour form and dissolves lipids simultaneously. The oil solvent solution, a

is removed and the dehydrated, defatted fish meat is finally desolventised. Finished product, fish cakes, are dried, powdered sieved and packed in airtight containers.

#### Canadian Process:

This was developed by Guttman and Vandenheuval in 1957. It is a two stage process.

Process A: The comminuted fish is suspended in water containing phosphoric acid and the pH is brought upto 5.5. Then the fish meat is cooked for 30 minutes at a temperature

of 167 to 172°C with constant stirring. It is filtered and the cakes are washed with hot water until the filtrate is practically odourless.

Process B: The pressed cakes are suspended in isopropyl alcohol (double its volume) and refluxed for 15 minutes. The entire mass is filtered. The cakes are pressed free of solvent and again washed with its double the volume of isopropyl alcohol. The fish cakes are again pressed free of solvent, dried and powdered. The residual solvent is removed usually by vacuum drying.

#### Production of FPC in India

CFTRI Process: The Central Food Technological Research Institute, Mysore have successfully developed a process for production of FPC using ethyl alcohol as solvent to remove lipids from the cooked fish cakes.

CIET Process: The process developed at Central Institute of Fisheries Technology, Cochin is given below:

The comminuted fish meat is cooked with an equal quantity of water containing acetic acid (0.5% by volume). It is left for an hour to stand. The fish oil separates on the top of water. It is skimmed off. The cooked fish is pressed in canvas bags to remove water. The pressed fish cakes are suspended first in ethyl alcohol which also removes moisture from the cakes. It is then extracted with an azeotropic solvent mixture of hexane and alcohol (33.2 mole percent of ethanol, B.P. 58.69°C). After the solvent extractions, the defatted

mass was pressed in screw press and dried under vacuum. The dried FPC was steam stripped to remove the last traces of solvent, afterwards, it was again dried under vacuum and then powdered and packed.

### Characteristics of FPC

It is colourless, odourless, tasteless product, stable upto 2 - 3 years in room temperature with little change in flavour. The Food and Agricultural Organization of the United Nations has prescribed standards for FPC. The ~~prox~~ proximate composition of FPC prepared from threadfin bream by the CIFT process is given below and it is compared with standards of FAO type A F.P.C.

<u>Moisture</u>	<u>CIFT PROCESS</u>	<u>FAO Type A</u>
Protein (6.25 x N)	67.7%	67.5
Pepsin digestibility	98.0	92.0
Available lysine (as % of protein)	7.9	6.5
Total lipids	0.4	0.75

FAO has also prescribed standards for two other types of FPC called Types B and C. In type B the residual fat will be present to the extent less than 3% and the type C, which is crude fish meal, the fat content can be upto 10 percent.

### Uses of FPC

FPC as such cannot be consumed. It can only be incorporated in foods, low in protein content, <sup>to</sup> enhance their protein value. It can be incorporated in breads, biscuits

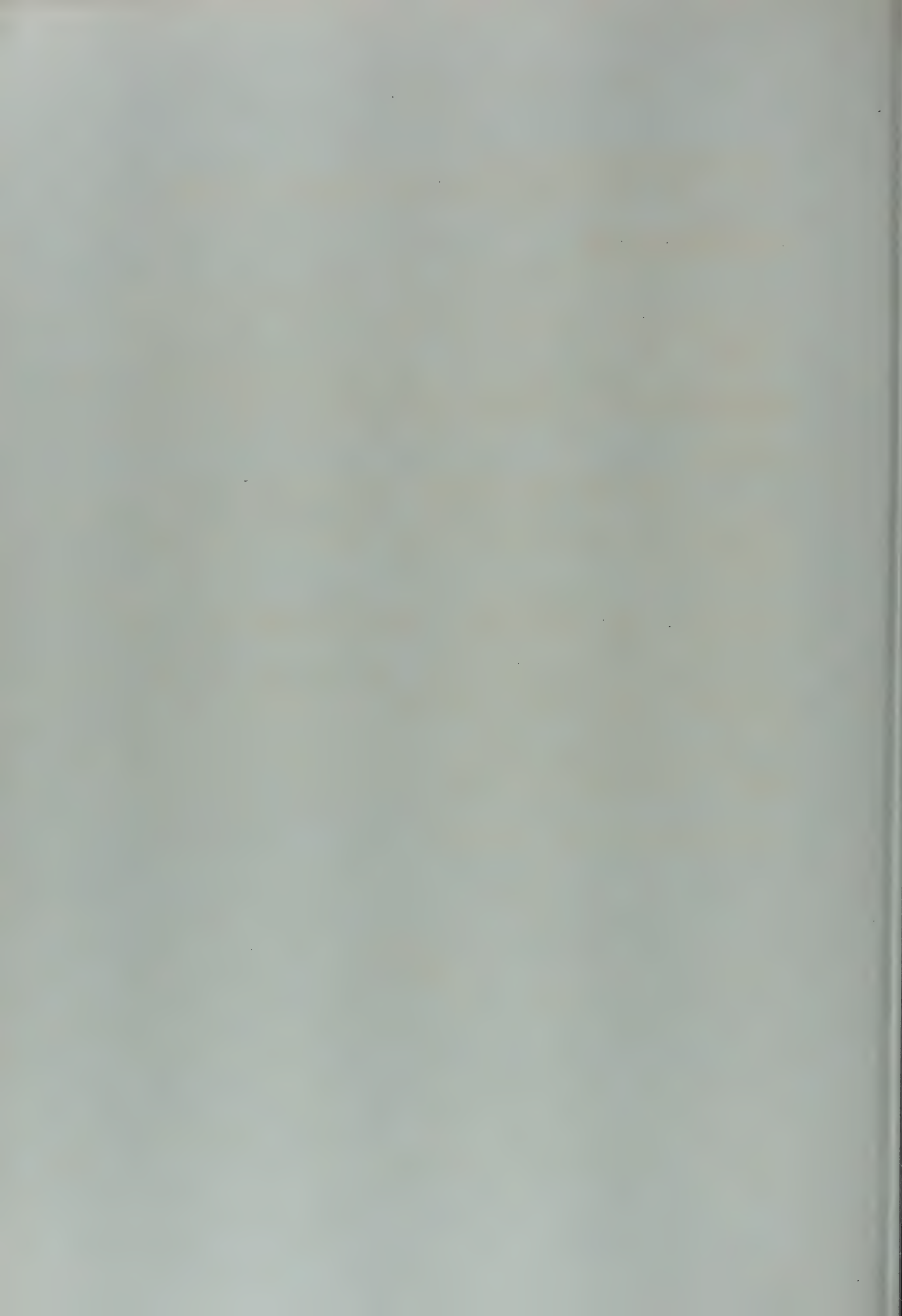
and a number of food items safely upto 10 percent.

### Prospects of FPC

Since in the process of the preparation of FPC there involves a solvent extraction, the harmful effects of residual solvents have evoked considerable criticism. Many countries have not so far given clearance for sale of the product.

However, FPC can find application in protein supplementation in many countries where there is a low intake of protein. But in recent years the cost of fish has increased at least two to three fold. This has considerably increased the cost of production of FPC. This, coupled with the restrictions imposed by several countries in marketing solvent extracted FPC has considerably limited the prospects of this product. Hence, a breakthrough in the manufacturing and marketing of this product is yet to be achieved.

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# PASTE FISHERY PRODUCTS AND FISH FINGERS

P.A. Perigreen

## I Paste fishery products

The origin of paste fishery products dates back to the 15th Century in Japan. These products are now very popular in Japan. ~~The paste fishery products which are very popular in Japan.~~ The paste fishery products which are very popular in Japan are Kamaboko, Chikuwa, Hanpen, Sumaki and Satsuma-age. The basic procedure of preparation of all these products is the same namely, ground fish meat is formed into different shapes and heated by various methods such as boiling in water, steaming or combination of steaming and boiling or frying. The fish sausage and ham are also paste fishery products.

### 'Kamaboko'

Fishes having high percentage of myofibrillar protein are most suitable for the preparation of ~~Maka~~ Kamaboko. The following species are suitable for this purpose croaker, flat fish, shark, cuttle fish, eel, flying fish etc. Kamaboko can be prepared from single species or mixed species.

The fish are washed, scales removed, if necessary, headed and eviscerated. After washing and draining the fish are filleted. In the case of sharks the meat is cut into pieces with a knife. The separation of meat from the fish can also be done by a meat picking machine. The meat is crushed with a chopper and the finely crushed meat is soaked in water for 24 hours to remove fat, blood, odorous components etc. with occasional replacement of wash water with fresh water. After washing the meat is pressed in a canvas bag to remove free water. The pressed fish meat is ground in a stone grinder for  $\frac{1}{2}$  hr. At this stage seasoning materials like sodium chloride, monosodium glutamate, sugar etc. are added along with

starch and polyphosphate and grinding continued for a few minutes. The amount of starch depends on the type of fish meat used. If the degree of adhesion of the meat is weak more starch has to be added. The fish paste thus obtained is moulded into desired shape upon thin wooden plates and cooked in flowing steam for 80-90 minutes. The time of cooking depends on the thickness of the fish paste blocks. After steaming, the fish meat paste (Kamaboko) is soaked in water for 10 min. This treatment imparts a brilliant bright colour to the product. The Kamaboko is packed in polythene and the shelf life at room temperature is 2 to 3 days.

#### 'Chikuwa'

The procedures for the preparation of 'Chikuwa' are the same as those for Kamaboko before shaping. The ground fish meat paste is molded as a cylinder around a revolving brass pipe and conveyed through long charcoal fire furnace. After cooking the brass pipes are removed and the finished product Chikuwa is wrapped in polythene paper and packed in cartons.

#### 'Hanpen'

Crushed yam and rice flour are added to the ground fish meat and put in a small wooden vessels of required shape. The shaped fish meat paste is heated in hot water at 85°C till it floats<sup>in</sup> the hot water to the surface. Product is removed from water, cooled and packed.

#### 'Satsuma - age'

'Satsuma - age' is made of ground fish meat prepared by the same procedure as Kamaboko. Cut blanched carrots and seasoning materials are added to the ground meat, mixed in a grinder, formed in various shapes and fried in oil.

' Sumak i '

Ground fish paste is spread as a sheet with a flat knife having a dull edge. On this additional ground fish meat dyed with red or blue colouring material is piled and spread. The piled sheets of ground fish meat paste are rolled and is covered with a bamboo blind. This is then steamed.

Tuna paste

Ingredients:

Tuna meat (cooked)	5 kg.
Starch (Rice flour or maida)	2 kg.
Sugar	0.3 kg.
Salt	0.25 kg
Mono sodium glutamate	0.02 kg
Hydrogenated fat	0.3 kg
Water	1.5 litres.

The cooked tuna meat is homogenised with water and the other ingredients added, mixed well and kneaded in a kneading machine. The paste product obtained is preserved by canning.

Sardine paste

Ingredients:

Dressed sardine	..	5 kg.
Water	..	2.5 kg
Hydrogenated fat	..	2.5 kg.
Salt	..	0.5 kg.
Garlic	..	0.7 kg.
Sodium Caseinate	..	0.19 kg.
Spices	..	0.06 kg.
(pepper, cardamom etc.)		

Cook the fish with water, add all the other ingredients, pass through a high speed cutter and then passed through a homogeniser. The paste obtained is packed in cans and processed. This can be used as bread spread, , in sandwiches etc.

### Shrimp extract

Prepared from prawn head and shell waste. The waste is washed thoroughly in potable water and minced in a meat mincer. Minced waste is boiled with 0.5% of its weight of sodium hydroxide for about 1 hr. and filtered to remove the shell material. Filtrate is neutralized with hydrochloric acid initially and with acetic acid towards the end to pH 6.8 to 7 and concentrated to a semi-solid mass with a moisture content of 35 - 40%. This is packed in lacquered cans ( 301 x 206 ), exhausted, sealed, sterilized at  $0.7 \text{ kg/cm}^2$  for 45 min., cooled and stored at room temperature .

The shrimp extract can also be preserved by freezing after packing in polythene bags.

### Composition of shrimp extract

Moisture %	..	41.84
Protein %	..	39.61
Fat %	..	6.56
Ash %	..	9.62

The yield of shrimp extract is 20% on the basis of raw material. Shrimp extract can be used as a flavouring agent.

## II. FISH FINGERS

Fish sticks, popularly known as fish fingers are uniformly shaped pieces of fish dipped in batter, breaded and frozen in consumer size packages. They are packed both in precooked and uncooked forms. The pre-cooked fingers which have been deep fried in oil before

freezing are served after heating them in an oven while the uncooked fingers are meant for those consumers who prefer to do the frying themselves.

#### Method of preparation

Minced ~~fin~~ meat is frozen in form of slabs of suitable size. The slabs are then sawed into fingers of uniform size. The size of fingers varies with different processors. Usual size of fish fingers is  $5/8 \times 5/8 \times 3$ ". While still frozen, the fingers are given a coating with batter and then a coating of breading. The breaded fingers are conveyed through deep fat fryer. The fingers are then drained, cooled, packed in cartons, immediately frozen and stored. Fish fingers can also be prepared using fish fillets. The frozen fillets are cut into the form of fingers, coated with batter, breaded and fried.

#### Preparation of batter

The composition of a typical batter used for the preparation of fish fingers is given below:

Wheat flour	:	73%
Salt	:	1%
Dehydrated whole eggs	:	8%
Milk powder	:	6%
Hydrogenated vegetable fat	:	9%
Monosodium glutamate	:	1.5%
Baking powder	:	1.5%

Mix all the ingredients in a blender. Hydrogenated vegetable fat is added after melting. Prepare the batter by mixing the ingredients with  $1\frac{1}{2}$  times/its weight of water.

Breading mix

Wheat flour	:	40%
dehydrated whole eggs.	:	10%
Milk powder	:	3%
Salt	:	1%
Monosodium glutamate	:	1%
Fine bread crumbs	:	45%

All the solids are mixed to get a fine powder.

The composition of batter and breadmix can be varied according to consumer preference. Good quality fish fingers are prepared by dipping the fingers in egg white and rolling in plain bread crumbs. Both the precooked and uncooked fish fingers will remain in good condition for over 6 months under frozen storage.

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DIVERSIFIED FISH PRODUCTS WITH SPECIAL REFERENCE TO THEIR  
MICROBIOLOGICAL ASPECTS

Dr.C.C.Panduranga Rao

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Fish is meant to be eaten and forms a very important food item. Being an item rich in animal protein and needing low energy and cost imports, every effort should be made to increase their availability and utilisation.

Briefly looking to the demand and availability picture of world fisheries, it appears that about 110 million tonnes of fish are required by 2000 A.D to feed the World population. Out of this requirement, about 80-90 million tonnes are expected to be harvestable from marine sources while the remaining amount is to come from inland water bodies and aquaculture. Coming to the Indian scene, target of 2.2 million tonnes of marine fish and 1. million tonnes of fish from inland resources have been set to be achieved by end of VI Plan. It is expected that major part of the increase will be in the form of small fish, for whose utilisation proper technology is needed since they cannot find a remunerative market as fresh fish. Apart from its use for human consumption, a considerable part of the marine landings also go for fish meal production, which is the major mode of utilisation of fish not going for human consumption.

Fishery technology is a very dynamic area and is to cater to the changing conditions such as resource availability,

changing management practices etc. The three significant factors that have changed the earlier situation in our country are i) declaration of EEZ and ii) decline in landings of prawns at least in some parts of the country and iii) availability of new resources as a result of newer technologies of aquaculture.

With the declaration of the Exclusive Economic Zone extending upto 200 nautical mile from the coast, an area amounting to 2 million sq. KM of sea, equivalent to the land area, has become available and it is left to the ingenuity of the country to exploit the fishery resources in this area and make them available for human consumption. The technological challenges involved here encompass both harvest and post harvest technology. Processing technologists should prepare themselves to work upon and develop suitable methods of utilisation of the increased amounts of the available resources and the new resources.

The second factor is declining prawn landings being encountered in certain parts of the country. The cause may be varied for such a situation and changes in available resources is not a new phenomenon. If we go through the development of World Fisheries over the past, such changes in resources were noticed in some of the countries and were handled appropriately. To cite a few instances California's sardine resources flourished in 1930's in the world market and collapsed in 1940's due to over-fishing. Similarly South African Pilchards took its place, which also later collapsed and Peru took its place and started supplies to South Africa. Similar changes occurred with Atlantic Whale

Industry and also with some other important pelagic fish such as herring, anchovies and sardines due to overfishing. Here also the processing technologists are to find out ways of developing suitable methods for utilisation of alternate available resources and also alternate uses of the available equipment and machinery.

Availability of new resources by culture techniques also make it obligatory to evolve suitable methods, of their utilisation. So these three main factors warrant new technologies to develop suitable products from the additional resources.

Different types of fishery products can be broadly classified depending on mode of utilisation into 3 categories i) those used for human consumption ii) those used for animal consumption and (iii) industrial products. Here we are restricting ourselves to those products which are used for human and animal consumption, in respect of which microbiological quality is of utmost importance.

Microbiology is an older science than fishery science. Fishery Science can be said to have had its origin in the late nineteenth and early twentieth centuries, while study of microbiology commenced even in seventeenth century with the use of compound microscope to describe microscopical forms of life by van Leenwenhock, through a real Phillip to the study was provided by Louis Pasteur- 1850's to 1860's. Probably the earliest applications of microbiology to fish were in the form of different

bacterial isolations from various marine sources including marine sediments and fish by Certos in 1884 and Russel in 1892. Interest was not much evinced in microbiological aspects of fish till the early part of twentieth century though bivalve molluses continued to receive the attention of microbiologists due to their involvement in human disease. The observations by Anderson(1907) and others in subsequent years that fish spoilage was mainly due to bacteria and spoilage bacteria happened to be there normally occurring in fish triggered renewed interest in microbiology of fish.

For any type of processing it is very essential that the raw material is of good quality. No sophisticated method or processing equipment can turn out a quality product out of poor quality raw material but on the other hand poor raw material can put to nul any sophisticated processing method or equipment. Poor quality raw materials will not only yield poor quality finished products but will lead to build up of infectious organisms on surfaces and equipment which at a later stage may be responsible for poor quality products even from good raw material. In addition even when the raw material is subjected certain processes such as heating or freezing which are believed to be inimical to some of the bacteria under defined conditions, the ultimate inimical effect depending upon so many other factors such as initial bacterial load, the thickness of the item, influencing penetration of heat, cold etc. and the other characteristics of the item itself. That is why, even though

the raw material is expected to be subjected to such processes, it is very essential that the raw material should be of good quality and should be maintained in good quality by hygienic handling.

Generally fish from temperate or cold waters appear to contain lower counts than fish from tropical waters. Qualitative cold water fish carry mainly *Moraxella*, *Acinetobacter*, *Pseudomonas*, *Flavobacteria* and *Vibrio* as compared to micrococci, corynebacteria and *Bacillus* spp. in fish from warm waters. This points out to the psychrophilic nature of the former, and mesophilic character of the latter. The major sites of bacterial loads are skin surface, gills and intestines. The qualitative pattern of bacterial flora of crustaceans is similar to fish. Yeasts of genera *Rhodotorula*, *Candida* and *Torulopsis* are quite frequently encountered while molds are rare in marine fish. Since spoilage of fish is mainly bacterial and in view of its time temperature relationship, it is essential that raw material is processed as quickly as possible after harvest and kept at a very low temperature in the intervening period to prevent bacterial multiplication.

In addition to the organisms picked up by the fish while in water, they can get contaminated by certain other human pathogens like *Salmonella*, *Staphylococci*, *E-coli* *coliform* etc. This can be prevented mainly by using potable water, ice of good quality and elimination of carrier human beings from handling fish during different stages of transportation and processing.

The effect of different methods of processing on the bacterial content of fish deserve consideration at this stage.

i) Freezing is one of the most valuable methods of preservation of fish and shell fish. Though frozen prawns, lobster tails and frog legs achieved a firm foot-hold in the export market, frozen fish and fillets are slowly trying to find their place. The general principles and common method of freezing fish and shell fish are well known. There is a common feeling that freezing destroys most of the bacteria associated with fish, which is not completely correct. The effect of freezing on bacteria of fish can aptly be stated as erratic and rather difficult to predict. There is often some reduction in bacterial content during freezing and subsequent cold storage. But by and large, the conditions of rapid freezing and storage at low, non-fluctuating temperature, which are required by fish for good quality also happens to be protective for bacteria. Even though some of the pathogenic organisms such as salmonella and v.parahaemolytic are generally said to be cold sensitive, there are great variation when they are present in fish. Gram negative organisms are said to be more sensitive to freezing than gram positive organisms while bacterial spores are highly resistant. Freezing can best be described as a very effective method of halting bacterial action and it simply preserves the bacterial status quo of the product.

2) Canning: Canning which involves heating process, usually destroys all pathogenic organisms and normal numbers of other organisms. When spores occur in raw material in large numbers or when recontamination occurs due to improper seaming or use of contaminated water for cooling, problem comes up. Sometimes thermophilic organisms such as *Bacillus stearothermophilus* survive heat treatment and multiply when cans are cooled slowly or during subsequent storage at high temp, producing "flat sour spoilage". Cans get blown or swollen due to survival of clostridial organisms especially *C. sporogens* due to defective seaming combined with use of contaminated cooling water. In some cases especially when oil is used as filling medium it is not possible to obtain sterility since oil give some protection to spores against heat.

Cured and dried food: Cured and/or dried seafoods are traditional in some of the developing countries like India while they are not importance in the industrialised countries. In India, the most common mode of fish utilisation next to fresh fish, is curing and/or drying. Just as for any other quality fish product, fish in good condition are essential to get dried fish of good quality. This aspect needs attention of the cured/dried fish trade in the country. As against the capital intensive freezing and canning industries, dry fish industry, is labour intensive and is admirably suited for adoption by the weaker sections of the society. Salting and drying brings about a lowering of  $w$  (moisture) which below a certain limit is inimical to bacteria. In addition higher

concentrations of salt are also bactericidal to some bacteria and yeasts due to osmotic effects.  $a_w > 0.90$  permits bacterial growth). However even some salt-sensitive bacteria such as salmonella persist in dried sea foods for quite sometime. Generally the microbial content of salted, dried seafoods is dominated by micrococcal and gram positive rods. Mould spores find ready access to dried foods and they germinate and grow even if they become slightly moist. Bacteria most commonly responsible for spoilage of salted fish are halophilic or halotolerant types, especially the Halobacterium Sp and Halococcus Sp. These arise from contaminated solar salts and grow when  $a_w$  is still above 0.75, producing pink or red discoloration. The most troublesome mold sporendonema epizoum in salted seafoods is the one causing dun and brown discoloration with localised decay. Sorbic acid and propionic acid can prevent the growth of these moulds.

Smoked:- Smoking is used to give a desirable flavour, odour and appearance in industrialised countries while in others, it is used as a method of preservation, achieved by drying. The actual smoking is usually preceded by brining intended to improve texture and flavour. The bacterial flora of finished product is influenced essentially by brining process and the temperature attained by the fish during smoking. For instance, Cocci (61%) and non-sporing rods (34%) dominate the product when smoked at  $140^{\circ}\text{F}$  ( $60^{\circ}\text{C}$ ) and when smoked at  $160^{\circ}\text{F}$  ( $71^{\circ}\text{C}$ ), sporeformers(8%) dominate followed by non-spore forming rods(10%) and cocci(9%).

Bacterial spoilage of smoked fish is mostly related to growth of non-sporeforming rods, which survive smoke processing or are introduced during handling of finished product.

Penicillium and Aspergillus spp. of molds are most common cause of spoilage of smoked fish which grow readily oil refrigeration temperature. The source of these moulds appears to be saw dust used for producing smoke.

Smoke appears to be bactericidal to some extent.

#### Fish Protein Concentrate

FPC may be in the form of liquid, paste or powder, but the FPC that is being dried on a commercial scale in different parts of the world is a powder. They have more than 70% protein and are prepared under hygienic conditions so that bacterial counts are low and potential human pathogens are absent. As per U.S.F.D.A., regulations, food grade FPC should not have bacterial counts exceeding 10,000/gm and E.coli or other pathogens. It is possible to achieve these requirements if the accepted norms of hygienic handling and factory practices are followed, since the processing techniques themselves are sufficiently bactericidal. It is very important to have plant machinery which is amenable for thorough cleaning periodically as otherwise the protein rich material residues in different locations of the plant can encourage bacterial growth. A point deserving attention in the bacteriological examination of FPC is its nature to settle very

rapidly in dilution blanks. Blending techniques combined with are employed to overcome this problem. The possibility of rapid plating of contamination with moulds and subsequent mycotoxin contamination should be prevented by moisture control preferably maintaining it below 17%, using water proof bags and storing in dry place.

#### Fish meal:

Coming to the fish products intended for animal consumption, fish meal is the most important, the world over. About 1/3 of world fish production is utilised for production of fish meal. The major microbiological problem concerning fish meal has been that of salmonella. Fish meal has been extensively accused for the spread of salmonella serotypes throughout the world. In some cases raw material itself was contaminated while in some others fish meal kept unprotected in open was contaminated by birds and rodents. U S Department of Agriculture along with public Health services surveyed the production procedures of fish meal in their country and made suitable recommendations for preventing salmonella contamination of fish meal. Another potential health problem concerning fish meal is aflatoxicism. Fish meal with 22% moisture and massively inoculated with A. flavus and kept at 30°C for 5 days supported toxin production.

#### Bivalve molluscs:

From the commercial view point, bivalve molluscs belonging to class PELECYPODA comprising of mussels, clams and oysters are of importance. Different products intended for human

consumption have been developed in recent times from these shell fish. Being filter feeders, they concentrate microscopic particles including bacteria and chemical substances. To give an idea, if the waters contain 1 mg/l litre of zinc, oysters living in these waters show concentration as high as 1,50,000 µg./gm. In respect of bacteria the concentration appears to be less, ranging from 10 to 30 times. Mostly the products involve only partial heat treatment. So they require special sanitary control measures aiming at direct environmental control of the growing waters. Total coliform group has been chosen as the sanitary indicator group to determine the quality of shell fish growing waters. Water criteria for determining areas suitable for direct harvest and human consumption have been in existence since early 1900's (Ref. "Recommended procedure for Bact. exam of Seawater and shell fish"). The coliform count will help differentiate between shell fish which are fit to eat and those which are not. National shell fish sanitation programme established the following standards for raw shell fish. The Criteria are faecal coliform group (not total coliforms) should not be above 230 MPN/100gm. and 35°C plate count not above 500,000/gm.

### Public Health Microbiology of Seafoods

#### Fish & Crustacean shell fish:

Fish and non-molluscan shell fish from temperate and cold waters have been rarely associated with major episodes of food borne in techniques/intoxications, but in tropical regions

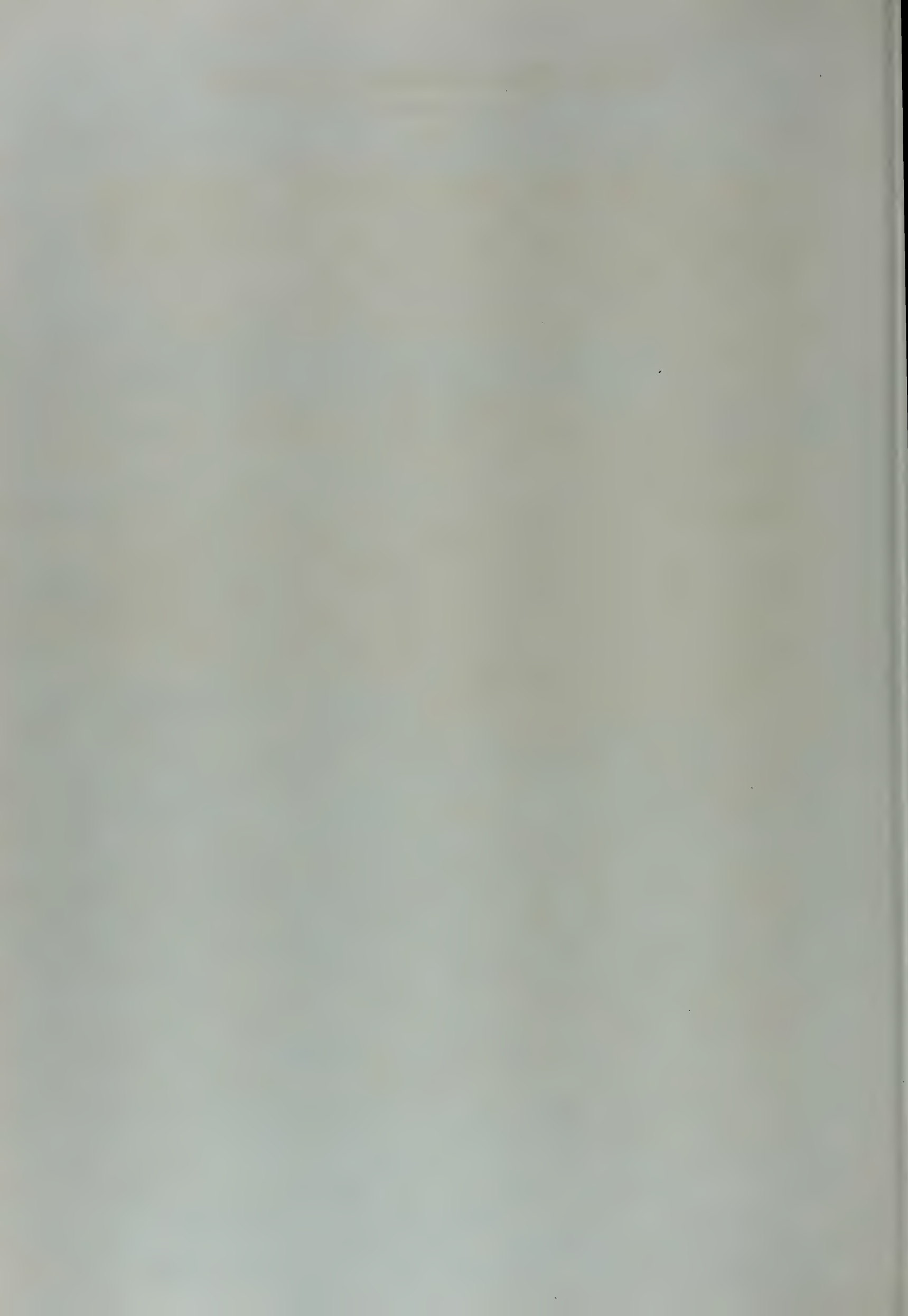
there is reason to suppose that they play a larger role in human disease.

In India, there is no system of reporting and investigating food poisoning episodes with the result that no systematic information is available on this aspect. Having a few isolated cases of food poisoning mostly due to staphylococci transmitted through milk products. But however daily newspapers report very frequently large scale episodes of food-borne illnesses but most of them do not receive the very much needed investigations including epidemiological studies. Fish pick up V.parahaemolyticus and C.botulinum especially type E from the marine environment itself. Usually outbreaks due to these organisms result from errors in processing. V.parahaemolyticus has been reported from a considerable number of cases of human gastroenteritis at different places in the country. The organism has also been recovered from fish and/or prawns. The other potential food-borne pathogens of importance are Salmonella, Staphylococci, E.Coli and C.perfringens. Salmonella are isolated quite frequently from processed frog legs and prawns but appear to be very rare in fresh fish. Coagulase positive staphylococci are quite frequently isolated from fresh and processed seafoods. E.Coli especially entero pathogenic E.Coli have been reported from fresh fish. Salmonella is also to be kept in view while considering fish meal for use as animal feed. It will be worth-while noting in this connection that human salmonellosis due to certain new serotypes in U.K.,

were found to arise from imported fish meal. C.perfringens have also been isolated from samples of fresh fish/shell fish and further characterisation of the isolates will help a proper evaluation of their importance in relation to potential pathogenicity.

Molluscan shell fish are recognised sources of potential health hazard. Outbreaks of typhoid fever, infectious, hepatitis, shell-fish poisoning etc., where molluscan shell fish were involved are on record. According to Clew (1973)" A truism that public health workers should keep in mind is that shell-fish harvested from contaminated waters are not going to be made clean in shucking-packing processing. Sanitary control of shell-fish must begin at the growing areas".

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## ROLE OF FISHERY WASTE IN ANIMAL FEEDS

K.G.Ramachandran Nair

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Apart from fish consumed either in the form of fresh, cured or processed fish a variety of products and by-products have been developed. The most important of these are fish meal, fish ensilage and oil. In addition to these prawn heads, shell waste and squilla form a sizeable amount which are now thrown out as waste. Fish meal and shark liver oil are now extensively used in the formulation of cattle and poultry feeds. Prawn shell and squilla are also rich in protein and they can also be incorporated in animal feeds.

### FISH MEAL

Fish meal is a highly concentrated nutritious feed supplement consisting of high quality protein, minerals, vitamins of B group and other unknown growth factors. It is produced by cooking, pressing and grinding the skeletal remains along with the adhering proteinaceous tissues of fish from filleting or canning operations or by processing whole miscellaneous fish mainly caught along with prawns which include jew fish, sole, silver bellies ribbonfish and the like.

Traditional fish meal production in India was from the sundried fish collected from various drying centres all along the coast and the product was chiefly used as manure. Better quality fishmeal has been a prominent item of export from the very beginning of this industry. The importance of improving the quality of fishmeal was felt and Indian Standards Institution has brought out the Indian Standard Specifications (IS:4307-1967) for fishmeal as live stock feed for facilitating proper quality control.

Fish can be reduced to fish meal by wet and dry method.

### Composition of fish meal

The composition of fish meal differs considerably due to the variations in the processing condition and raw materials used. The range of proximate analysis generally obtained is as follows:

Protein	..	50 - 70%
Fat	..	5 - 10%
Ash	..	12 - 33%
Moisture	..	6 - 10%

Fish meal is rich in all essential amino acids. B group vitamins and minerals particularly phosphorus and calcium. Because of this valuable composition, fish meal finds place as important feed supplement to poultry and cattle.

### Mineral content of fish flesh (mg per 100g of flesh)

	Range	Average
Sulphur	100 - 300	200
Chlorine	60 - 250	100
Sodium	30 - 150	60
Potassium	250 - 500	400
Phosphorus	100 - 400	220
Calcium	15 - 200	30
Magnesium	10 - 60	30
Iron	0 - 475	1
Copper	0.04 - 0.06	0.025
Iodine	0.01 - 0.5	0.17
Fluorine	0.5 - 1.0	-
Manganese	0.01-0.05	0.025
Zinc	0.7 - 3.0	=
Lead	0.005 - 0.02	-

## FISH ENSILAGE

Preservation of surplus fish and fish offal in liquid form for use as animal feed is an alternative for converting to fish meal. The process does not require heavy machinery and huge investment and therefore suitable for every fishing village.

Ensiling is achieved by treating the fish directly with mineral acid (sulphuric acid), organic acid (formic acid) or by producing lactic acid in the system by fermentation to the required acidity for the preservation. In order to facilitate the production of lactic acid, carbohydrate in the form of molasses is added to the fish or fish offal and inoculated with lactobacillus arabinoses. Because of the production of lactic acid the pH reduces to 4.5. In all these processes the fish is partially digested and preserved by the acidity.

## LIVER OIL

As early as the middle ages fish liver oil was used for the treatment of Vitamin A and D. deficiency diseases. The therapeutic value of these oils was discovered in the 18th century and fish liver oil became a common medicinal product. Both vitamin A & D are present in certain fish liver oils. The most important fish liver oils are obtained from cod, haddock and shark. Halibut and tuna livers are also rich sources of vitamin A & D. The weight of liver, fat content, presence of vitamins are dependent on species, age of fish, nutritional status and stage of spawning.

In cod (Gadus collarius), coal fish (Pollahius vârous) and haddock (Melanogfammus) the weight of liver normally amounts to 4 to 9% of the whole fish and livers contain 45 to 67% oil. Species of shark such as dog

fish (Squalus acanthias) Greenland shark (Somniosus microcephalus) and basking shark (Cetorhinus maximus) have large fatty livers weighing 10-25% of the whole fish containing 60 to 75% oil. Halibut, tuna and whale have 1% liver having 4 to 25% oil with high vitamin and D potency. Depending on the oil content and Vitamin A potency fish livers are generally classified into 3 groups (1) low oil content - high vitamin A potency (2) High oil content low vitamin A - potency and (3) high oil content and high vitamin A potency.

#### PRAWN HEAD AND SHELL WASTE

The prawn head and shell waste comprises 50% the weight of whole prawns. In India the quantity of such waste from processing plants amounts to 50,000 tonnes annually. The proximate composition of prawn head and shell waste is as follows:

Moisture %	-	76.62
Ash % (dry basis)		31.13
Protein %	( " )	39.76
Chitin %	( " )	23.08
Fat %	( " )	5.05

The prawn shell can be dried hygienically, pulverised and stored which can be incorporated in poultry and fish feeds.

#### SQUILLA

Squilla caught along with prawns throughout the west coast of India, being difficult to separate the meat, is at present utilised only to a limited extent for making meal and the bulk of the catch is thrown back to the sea. The protein from squilla can also be extracted leaving the residual chitinous skeleton for industries based on chitin.

Proximate composition of squilla

Moisture %	78.84
Ash % (dry basis)	38.42
Protein % ( " )	44.71
Chitin % ( " )	14.7
Fat % ( " )	2.68

Cartilagenous bones of shark fins

The cartilagenous bones left behind in the extraction of shark fin is also rich in protein and minerals, which can also be incorporated in poultry feeds.

Proximate composition of cartilage residue of shark fins

1. Moisture %	14.70
2. Ash %	16.37
3. Protein %	55.09
4. Na +	77.71 mg/100g
5. K+	51.85 mg/100g
6. Ca <sup>2+</sup>	518.1 mg / 100g

Fish meal is extensively used in the formulation of cattle and poultry feeds. In poultry feed it is an essential constituent. Fishmeal is used upto 25% in starter and 20% in layer mash and broiler mash. The results of feeding experiments conducted using starter feed is as shown below:

Traits	<u>Diet</u>	
	Control	feed containing 25% prawn shell
Weight gain (g)	126.7	179.0
Feed intake g/chicks	598.0	601.0
Feed/gain ratio	4.7	3.4
Survival ratio	29/30	30/30

1. The study was conducted for growth on chicks of 25 days age for a period of 3 weeks.
2. The chicks utilised for this study belonged to white leghorn breed.

Partially demineralised prawn shell powder and squilla protein were incorporated in fish diets and were found to give satisfactory weight gain. Feed containing partially demineralised prawn shell powder was found to give very good growth in Penaeus indicus. Squilla as such was squeezed and the resulting protein extract was tried for feeding Penaeus indicus larvae. Now, it is extensively used in fish feed formulations. Fish meal is also used in pet feed formulations in other countries. Fish liver oil, mainly shark liver oil is used for feeding cattle because of its high vitamin A & D content. With the development of chitosan manufacture, high quantities of protein extract of prawn shell will be available which can also be used as a potential protein source in animal feeds.

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## PRODUCTION OF SHARK FIN RAYS

P. Madhavan

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Of the total marine fish landings in India, elasmobranches contribute about 4 to 5%. Tamil Nadu, Kerala, Gujarat, Maharashtra, Andhra Pradesh and Orissa have sizeable shark fishery. At one time sharks were valued for their liver oil rich in Vitamin A. The introduction of cheaper synthetic vitamin was a serious setback to the world shark fishery.

The outstanding feature of shark is that every part of shark is extremely valuable though not fully utilized due to various reasons. The fins, skin, meat, liver and teeth all have high commercial value. But in industrial practice it is difficult to utilize all the parts simultaneously because all sharks are not suitable, due to size and biological reasons apart from technological problems. While most species are edible the premium as far as meat is concerned is enjoyed by the smaller shark, but it cannot yield hide and fins commanding high prices. Similarly shark meat deteriorates rapidly and must be chilled soon after catch to preserve the quality which affects adversely on the commercial value of the skin. The value of livers is now low, except of liver with high content of squalene which are found only in a limited number of deepwater sharks.

### Shark fins

Shark fins are in great demand particularly among the Chinese, for making the gourmet or ceremonial dish and shark fin soup. Dried shark fin is an item of export from India mostly to Singapore, Hongkong and the United Kingdom. Of the 37 species of sharks available in Indian waters, though fins from several varieties are exported, only a few fetch good prices, the maximum being fetched by "Ranja" (Rhynchobatus djiddensis). Other major varieties are "Pison" (Scoliodon walbheensi) and "Khada" (Carcharinus melanopterus). Fins from all sharks over 1.25 m. in length and from smaller ones are commercially valuable except those from nurse shark (Ginglymostoma cirratum) and the pectoral fins of the saw shark (Pristigaster nudipinnis). Fins from hammer head, mako, blue and grey shark are more highly priced than those from others.

The commercial value of the fins depends on their colour, size, variety and quality. Depending on the quality and quantity of rays present in the fins they are broadly classified into two varieties, generally known as black and white. The black fins usually fetch a lower price than the white fins. Fins are collected whole and together in complete sets, consisting of two pectoral fins, the first (rarely also the second) dorsal fin and the lower lobe of the tail fin. The pectoral fins contribute almost 50% of the total weight of of one complete set. They are sold by weight and the value depends also on the proportion. Fins are generally marketed

in dried form.

### Processing

The preparation of shark fin does not require any elaborate treatment, but care is needed in cutting, trimming and drying operations.

Fins are cut from sharks of about 125 cm. or more in length as soon as they are landed avoiding as much flesh as possible and are washed thoroughly in water after removing the adhering flesh. They are then dusted with salt in the ratio 1:10 (salt to fin), the cut portion being sprinkled liberally with salt. A little lime also is often sprinkled at the cut portion and the fins are set aside for 24 hours. They are then dried in sun after gently rinsing with clean water to remove solid salt and excess lime, to a moisture content not more than 10%. The dry fins are graded according to the size and type of the fin.

### Grades

#### 1) Dorsal, Ventral and Pectoral fins.

<u>Grade designation</u>	<u>Size in Cm.</u>
A	Below 10
B	10 and below 20
C	20 and below 30
D	30 and above

#### 2) Caudal (tail) fins.

A	Below 20
B	20 and below 30
C	30 and below 40
D	40 and above

The length of the dry fin is measured from the tip to the anterior corner (ISI-1969).

The most important point to remember is that fins not properly dried or trimmed are not accepted as first grade fins as the consumers of shark fins are meticulous about the appearance and quality of the cured product. Fins are cut from the shark in their finished form i.e. a concave ("half-moon") is cut into the base of the fin when removing it from the shark, except the lower lobe of the tail, which is removed by a straight horizontal cut. The cut should be made only as concave as to eliminate the meat, thus preserving as much of the fin as possible. The fins are dried in the sun as the trade prefers sun dried fins than mechanically dried ones. Similar to size and species the quality depends also on dryness and cut.

#### Fin rays

The dried fins are further processed, for the "rays". The process followed differs considerably from place to place and also depending on the quality and type of final product. The price of fin rays depends mainly on colour, length and thickness of individual strands, quantity of connective tissues and cartilage present, physical presentation etc. The products can be classified as semi-prepared skin off but otherwise retaining the shape, small individual strands made in the form of cake, individual strands, skin off but made into flaps by splitting at the middle along the cartilage.

A typical Indian process for the removal of skin, meat and cartilage from dried or non-dried fin is described. The fins are soaked in 10% (v/v) acetic acid overnight. They are then taken out and the shagreen (calcareous material similar to scales in fish) present on the skin is scrapped off using knife. The adhering scrap residues are washed away with water and further soaked in the same concentration of acetic acid in a separate vessel until they become soft. Separate container is used to avoid further contamination with the shagreen which is difficult to be removed afterwards. In the case of dry fins with 10-15% moisture the soaking is done for 4-5 days. Dried fins stored for longer periods will require longer soaking time or soaking in warm acetic acid for 1 - 2 hours. The skin and the softened gelatinous material are scraped off and rays are separated from the cartilage frame while washing with water. Alternately if the rays are to be extracted in clusters, as much gelatinous material as to hold the rays together at the base is retained. They are then washed free of acid and dried in sun or in an artificial drier at 50 - 60°C to a moisture content of nearly 10%. For processing in the form of flaps, after proper softening the fins are split into two flaps along the cartilage present at the middle and washed and dried. In the case of small fins which are difficult to handle during separation of the rays, they are soaked well and mechanically agitated to separate the rays. They are then dried in thin layers or in blocks.

In Japan, the production of shark fin rays is done in Ibaragi and Chiba Prefectures. Shark fins removed from the fish body are soaked in fresh water to soften for 4 to 5 days. After they become soft, the fins are heated in water at about 90°C for 20 - 30 minutes to swell. The skin is then removed and the cartilage at the base of the fin cut off to be used separately for "dried cartilage". Fin rays are separated from the base to the central part by removing the gelatinous substance present between the fin rays with bamboo spatula keeping the fins warm. The rays are pressed by half split bamboo to keep the base fin rays unseparated. They are then dried in the sun. Broken dried fin rays are pasted together with gelations made from the shark fin epidermis ("gesshi"). The pieces of fin rays are called "Shisai".

The dried fin rays in the form of separate strands are generally packed in card board boxes or wrapped in viscose films. The most expensive form of presentation is as semi-prepared skin off but otherwise retaining the shape. Tails can be prepared in this manner in one piece, but pectoral and dorsal fins have to be split into two. The price is governed by the colour, length and thickness of rays and the quantity of cartilage and the gelatinous substance present in between the individual strands of rays.

Though both white and black varieties of fins contain rays the yield from the black variety is only about half of that from white varieties. There exists wide variation in the

content of rays in the fins from different body parts, the caudal fins containing the least. Yield of processed fin rays varies depending on size and type of fin used and type of final product. Fins from black varieties contain rays interspaced with considerable quantity of cartilage whereas in the white variety the structure is constituted by rays and the gelatinous material with low cartilage content. In the caudal fin, though massive in appearance, only the lower lobe contains rays. The projection to the upper or anterior corner contains only few small sized rays which are difficult to separate.

Fins which are dried and stored for very long periods require to be gently warmed to avoid very long treatment otherwise needed for sufficient softening of the gelatinous material. Such heat treatment, though does not result in any significant difference in the yield, causes reduction in the length of the rays upto 30% with proportionate increase in the thickness, if the temperature exceeds 60°C during treatment. However, rays of such nature, thicker in diameter find fancy with certain consumers.

Shark fins/fin rays are a unique commodity in the sense that their market is both a seller's and buyer's market because the primary suppliers of the same are uninterested in their use as the major consumers are groups of Chinese population wherever they may exist. The prices depend on the assessment of the quality and presentation by the import market and the

suppliers are generally obliged to accept the evaluation of the buyers. On the other hand the importer cannot afford to miss the really busy season and therefore will be prepared to raise his offers to a reluctant seller.

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## UTILIZATION OF PRAWN SHELL WASTE

P. Madhavan

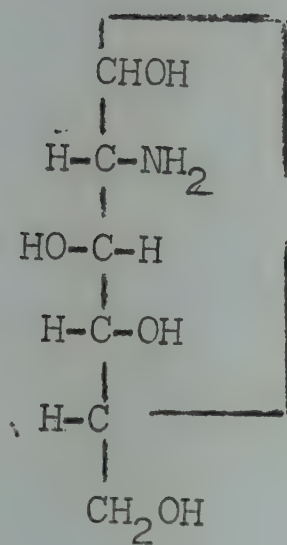
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The head and shell of prawn and other crustacea form the major fishery waste where crustacea are abundant in countries such as the United States of America, India, Thailand, Malaysia, Philippines, South Africa and Mexico. Shrimp, crab and lobster turn out huge quantities of shell waste in sizeable quantities, the disposal of which now presents a serious problem. This waste contains a good percentage of protein and chitin other than minerals. The protein can be extracted along with the flavour bearing compounds and converted into shrimp extract having potential use as a natural flavouring material.

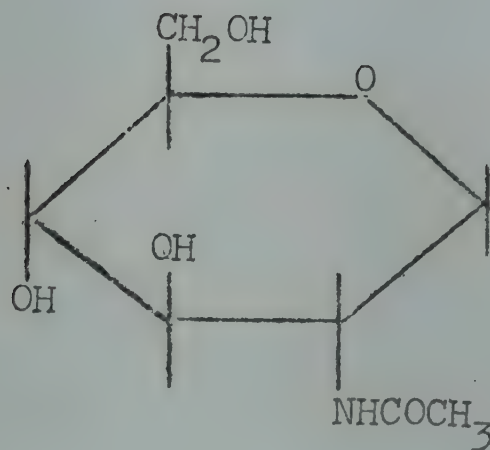
The chitinous skeleton from such waste and from other chitinous organisms like Antarctic krill, squilla caught along with prawns and the large quantities of fungi grown in fermentation systems producing organic acid especially citric acid constitute a potential source for industries based on chitin and its derivatives.

Chitosan, the deacetylated chitin, is one of such products which has application in many fields. It is a modified, natural carbohydrate polymer, 2-deoxy 2-amine glucose. It is a cationic polyelectrolyte, insoluble in water, organic solvents, and alkaline solutions and is soluble in most organic acids (formic, acetic, tartaric and citric) and dilute mineral acids except sulphuric acid. It can form ionic bonds and films. Because of these properties chitosan finds application in many industries.

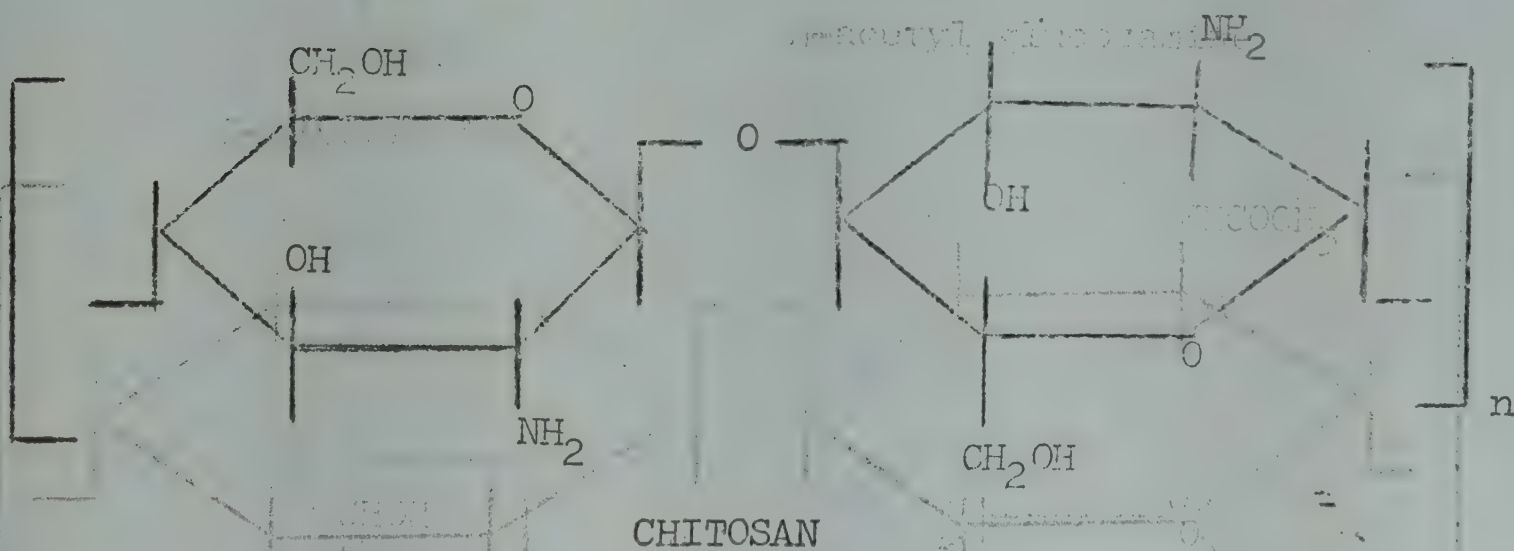
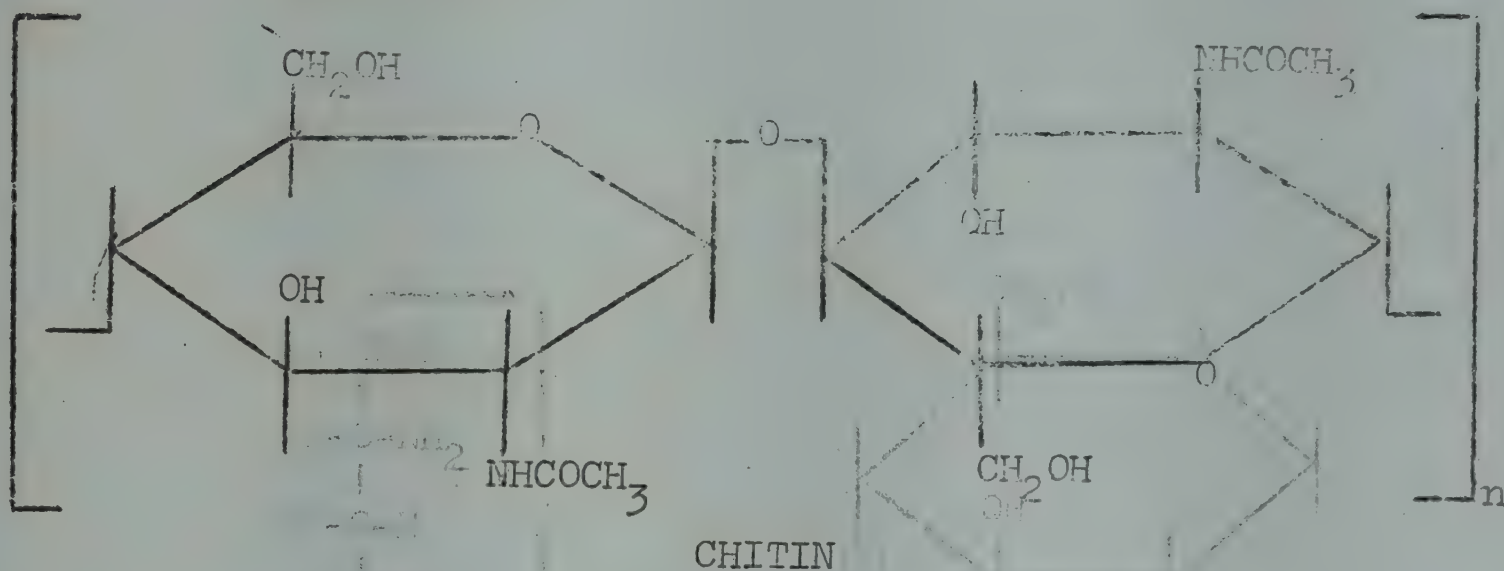




D-glucosamine



N-acetyl glucosamine





In India the quantity of such waste from prawn processing plants exceeds 50,000 tonnes annually. Squilla caught along with prawns throughout the west coast of India, is at present utilized only to a limited extent for making meal and the bulk of the catch is thrown back to the sea. The protein from squilla can also be extracted leaving the residual chitinous skeleton for industries based on chitin. Crab shell is yet another important waste of our marine catch. Similar to prawn waste the protein from crab shell can be isolated for making crab concentrate and the remainder forms raw material for chitin. Small penaeid prawns landed along the Maharashtra and Gujarat coasts, will also form a good source of raw material for chitin, after separation of protein.

#### Preparation of shrimp extract

Prawn head and shell waste meant for the extraction of the protein and conversion to shrimp extract should be collected fresh and stored in ice to minimise spoilage. It should be washed in potable water to remove all adhering dirt, sand and other extraneous matter. The protein is then extracted by boiling with 0.5% sodium hydroxide solution in water. The boiled mass is filtered through appropriate sieve to separate the residual shell. The filtrate is neutralised with hydrochloric acid initially, and with acetic acid towards the end to a pH 6.8 to 7.0. The neutralised filtrate is concentrated by boiling in an open steam jacketted kettle to a semi solid mass with a moisture content of about 35 to 45%.

The paste thus obtained can be packed in lacquered cans and heat processed. It can also be packed in polythene bags and preserved in frozen condition or can be dried under vacuum, powdered and stored at room temperature.

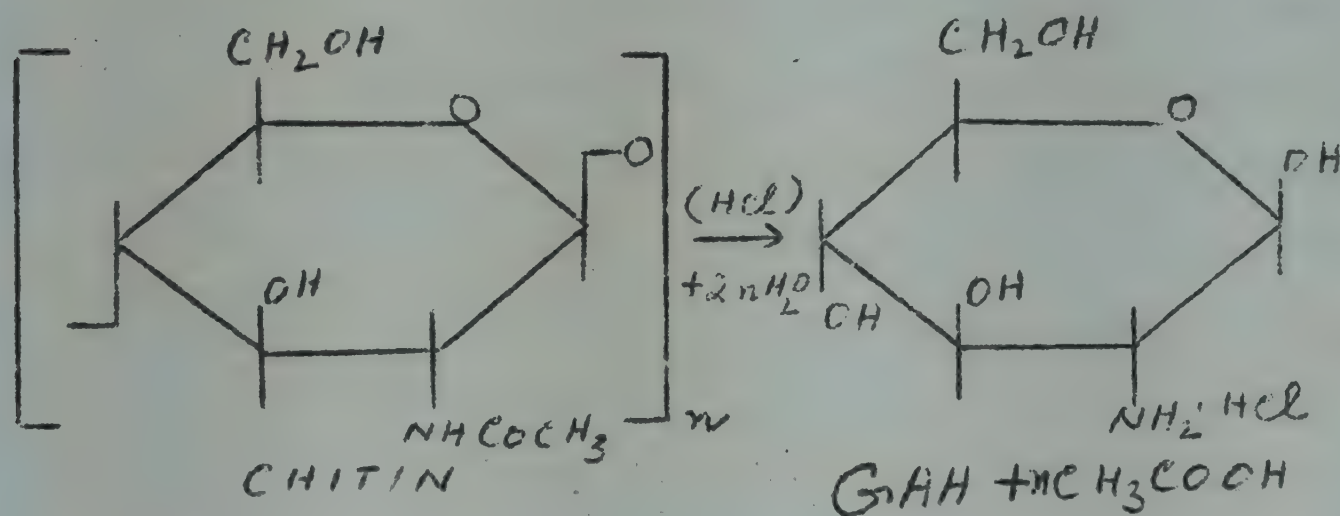
The paste so prepared is generally known as shrimp extract. It contains on an average 40% moisture, 40% partialised hydrolysed protein and 10% minerals. The yield is about 20% of the fresh head and shell.

### Chitin

The residual shell waste obtained after extraction of the protein with hot 0.5% caustic soda may contain small amounts of protein. This is then removed by boiling with 3% caustic soda for a few minutes and filtering off the liquor. The residue will contain the minerals present in the shell apart from chitin. It should be washed free of alkali before going for demineralisation. The demineralisation is done by treatment with dil hydrochloric acid at room temperature. The reaction mass should be gently stirred during treatment as the material has a tendency to float which is also aided by the effervescence produced during the reaction. The completion of demineralisation is indicated by the softening of the rostrum and also by the residual acidity which can be tested by using litmus paper. Dry shell waste from which the protein is not to be collected for making shrimp extract can be demineralised before deproteinisation with 3% caustic soda. Demineralisation reduces the volume of the shell considerably and therefore the deproteiniser

can hold more material if the demineralisation is done initially. If the chitin is to be used for further processing to chitosan 1.25 N hydrochloric acid must be employed for removal of minerals. At higher concentration partial breakdown of the polymer takes place which adversely affects the quality of the chitosan produced from it. At lower concentration of acid demineralisation will take longer time and if demineralisation is not complete, it will delay the deacetylation.

### Glucosamine hydrochloride



Chitin can be hydrolysed to glucosamine hydrochloride by adding concentrated hydrochloric acid and warming until the solution no longer gives opalescence or dilution with water. The excess acid can be distilled off under vacuum. The crude glucosamine hydrochloride is diluted with water and clarified with activated charcoal. The solution is filtered and evaporated under vacuum. The crude glucosamine hydrochloride coming as the residue can be separated from the mother liquor by adding alcohol.

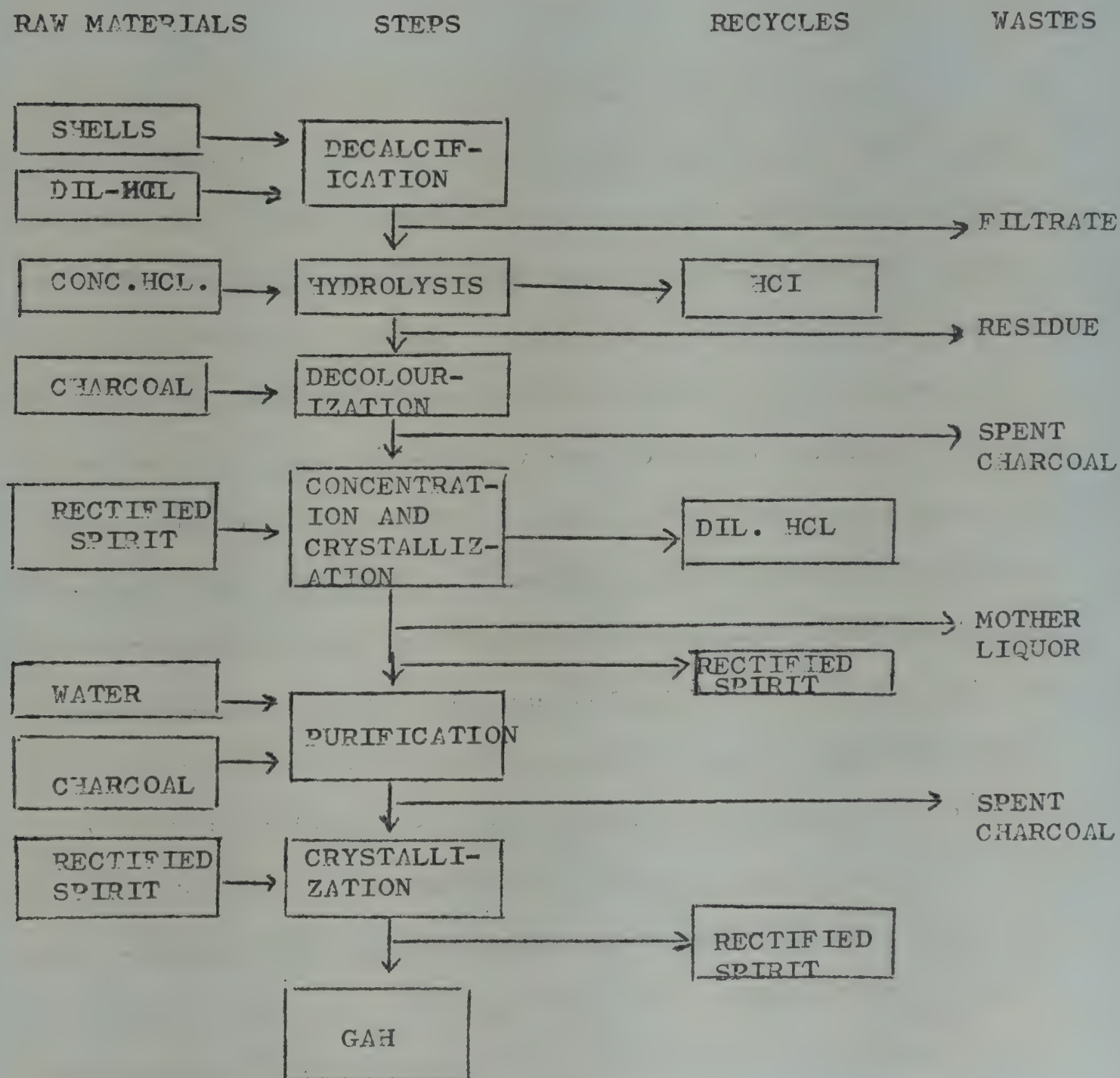
Process for the preparation of glucosamine hydrochloride

The deproteinised shell was added to three parts of 10N hydrochloric acid in a suitable reactor equipped with reflux condenser and stirrer. While stirring, the temperature of the reaction mixture was slowly raised to  $100^{\circ}\text{C}$  ( $\pm 5^{\circ}\text{C}$ ) and maintained at that level for 2 hr, when the hydrolysis was complete. The liberated hydrochloric acid gas was absorbed in water or dilute hydrochloric acid. The reaction mixture, which still contained the undissolved residue, was filtered after cooling. The residue was slimy and difficult to filter. After washing the residue with 1 part of water, the filtrate and the washings were mixed together and treated with 0.1 part of activated charcoal. Two treatments with charcoal were found sufficient to give a pale yellow solution, which was then concentrated under reduced pressure (20-25 mm of Hg) till GAH started to crystallize. After cooling the concentrate to  $0^{\circ}\text{C}$ , the crystalline GAH was filtered and washed with 0.1 part of rectified spirit to remove the adhering impurities. The product thus obtained was reasonably pure. Its yield was about 11-12% of the dry raw material (shells). Recovery of GAH from the mother liquor was not feasible. All quantities mentioned above are on the basis of dry shells.

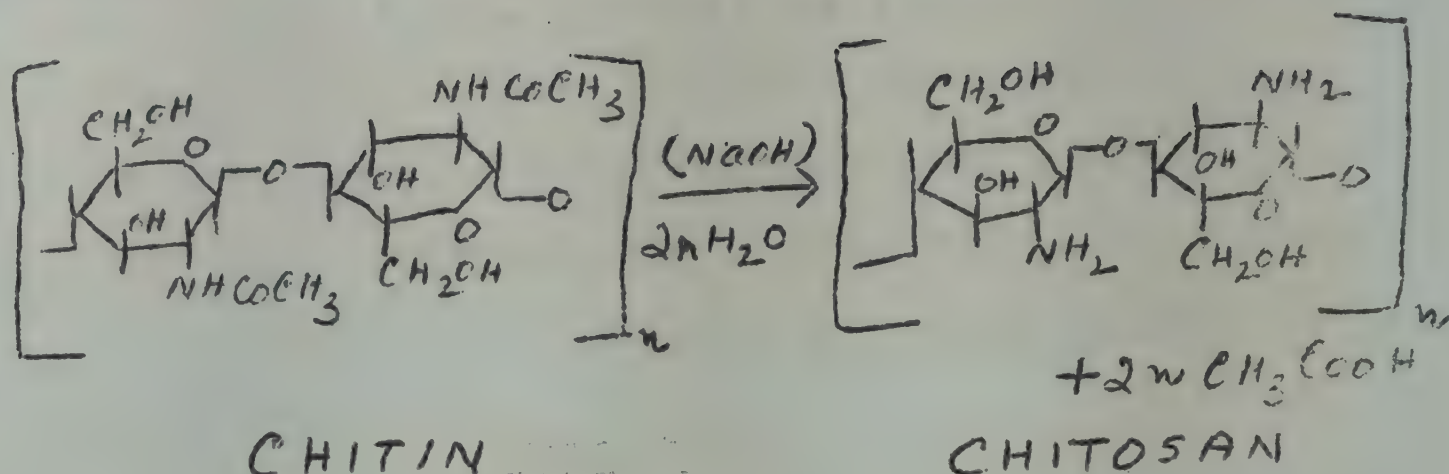
For further purification, a solution of one part of GAH in two parts of hot water was treated with 0.1 part of charcoal, and the solution filtered. Rectified spirit (8 parts) was added to the filtrate with stirring till crystals of GAH

appeared. After cooling the solution to 0°C, the white crystalline material was filtered, washed with 0.1 part of rectified spirit and air-dried. The yield was 90-92% in this purification. GAH could be further recovered from the mother liquor. The total yield of recrystallized GAH varied from 9.4 to 10.5% on dry raw material.

FLOW-SHEET



# Chitosan



Chitin meant for deacetylation to chitosan is to be either dried or centrifuged or pressed well to remove as much water as possible. The process followed should be strictly controlled for every batch so that the residual moisture present in the chitin cake should remain constant within reasonable limits. The deacetylation is done by heating at 90-95°C with 40% (wt/wt) caustic soda for 90-120 mts. The water present in the chitin cake should also be taken into account while preparing caustic soda solution. To achieve this (i.e., the final concentration of caustic soda in the reaction mixture to not less than 40%(wt/wt) 50% caustic soda is prepared and calculated quantity of it is added to the chitin cake. The reaction is followed by testing the solubility of the residue in 1% acetic acid. As soon as complete desolution is reached the caustic soda is removed from the reaction mixture. The drained caustic soda can be reused for the next batch of deacetylation by fortification if necessary. The residue is washed with water and washings collected for using as 3% sodium

hydroxide for the removal protein from the subsequent batches.

The chitosan obtained in the deacetylator is washed well with water to free it of from alkali. It is then centrifuged and dried in the sun or in an artificial dryer at a temperature not exceeding 80°C and pulverized to coarse particles.

At lower concentration of alkali and at low temperature the reaction proceeds very slow and therefore takes very long time for deacetylation. At higher temperature and at higher concentration of alkali chances of breakdown of the polymer is high and therefore results in lower viscosity chitosan.

Chitosan is almost colourless, light in weight and soluble in dil. organic acids but insoluble in water, alkali and organic solvents. It gives viscous solution when dissolved in dil. organic acids such as formic acid, acetic acid etc.

Description of the process for production of Chitosan  
from prawn shell waste in the Pilot plant at CIFT

The process described below uses dried prawn shell as the raw material. The extraneous matter present in the shell is removed by visual inspection and about 50 kg. of the shell is weighed and transferred into a polythene tank. Hydrochloric acid solution (1.25 N) containing 40 litres of commercial concentrated acid in 200 litres of water is added to the tank and stirred well. A vigorous reaction takes place by which the mineral matter present in the dry shell is dissolved in the acid.

At the end of the reaction which requires about an hour for completion, the brittle prawn shell is converted to a soft pliable mass.

More water is added to the tub and the contents are briskly stirred. By this process most of the adhering sand particles are separated and settle to the bottom of the tank while the shell floats in water. By means of a perforated basket the shell is scooped up. The sand and stone particles remaining at the bottom of the tank are discarded and a new batch of prawn shell and acid taken in the tank. Three such batches are prepared.

This demineralised shell is then fed to the deproteiniser by means of the bucket elevator. The deproteiniser is a jacketed kettle having provision for indirect steam heating. This vessel is also provided with a turbine agitator and temperature and pressure measuring arrangements.

3% sodium hydroxide solution is pumped from the storage tank to the deproteinizer. Heating for 30 minutes solubilises all the protein present in the shell in the alkali. This is drained off. The reacted mass is then transferred into a cement tank from where it is fallen for washing in small batches.

In the washing vessel water is added to the mass got from the above step and a vigorous stirring is given by means of a propellor type agitator fitted in the vessel. The effluents are pumped by means of an S.S. pump connected to the bottom of the vessel. A perforated false bottom fitted with nylon

net effectively prevents chitin from being carried away with the effluents.

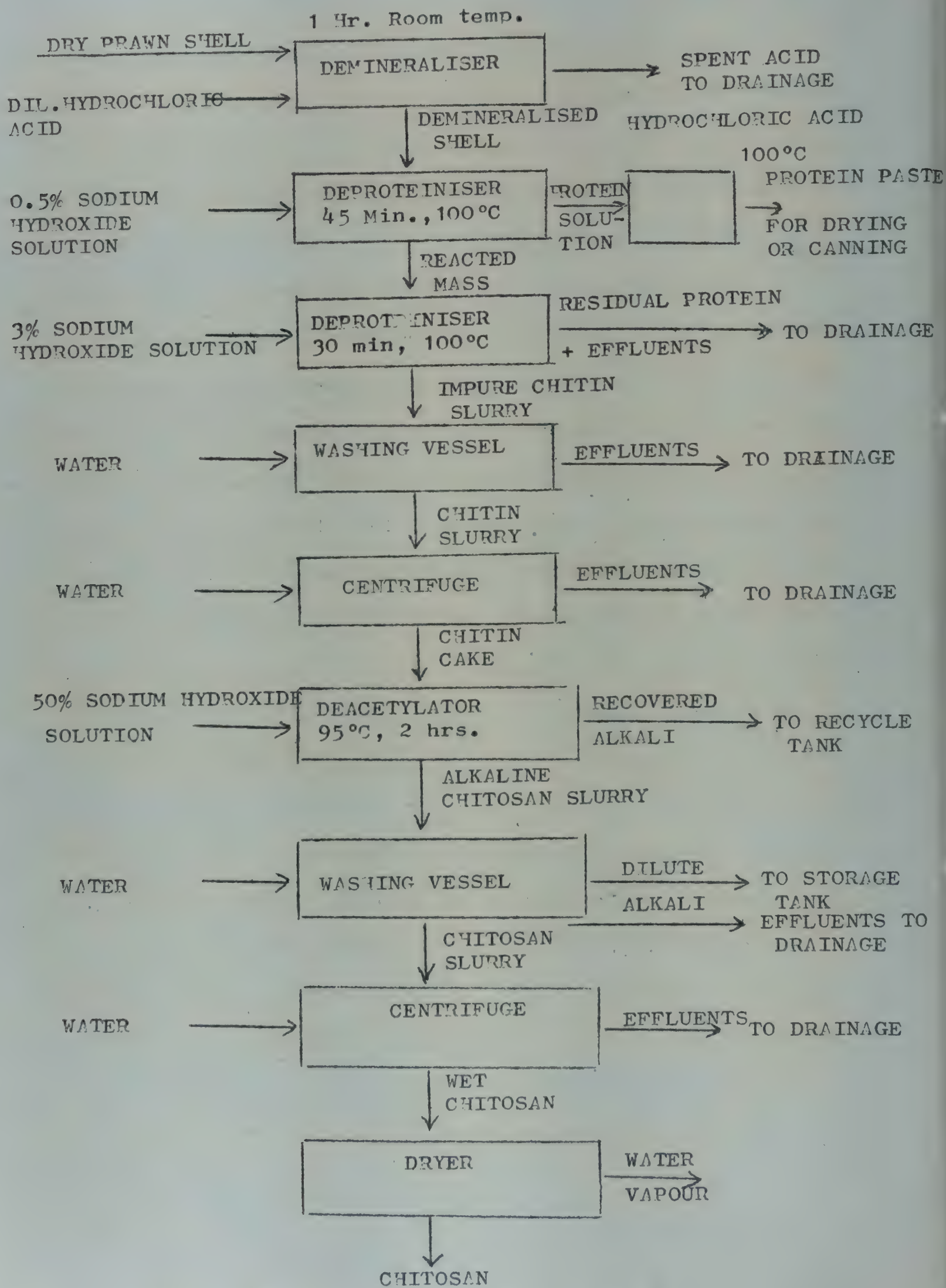
After the washing is over and the chitin is free from protein it is pumped to the centrifuge by means of a slurry pump connected to the washing vessel. Thorough centrifuging yields a wet chitin cake containing 70% moisture. Centrifuging is carried out in batches.

The chitin thus got is fluffed and fed to the deacetylation vessel. 50% (w/w) sodium hydroxide solution is pumped from the storage tank and the ~~same~~ contents are heated to about 95°C for about 2 hours. When the reaction is over as indicated by complete solubility, of the sample drawn, in 1% acetic acid, the steam supply is cut off and the alkali is drained off to the make-up tank. Then dil. alkali collected from the previous batch is pumped to the deacetylated mass, the contents stirred thoroughly and the concentrated alkali obtained thus is also transferred to the make-up tank where its concentration will be made up to 50% by addition of sodium hydroxide flakes and stored for future use.

The slurry from the deacetylator is then transferred to the cement tank from where it is taken to the washing vessel in small batches. Wash water is added and the dilute alkali solution is pumped to the 3% alkali storage tank. When the effluent contains a weak solution of alkali it is pumped to the drainage.

When the chitosan is fully freed from traces of alkali

FLOW DIAGRAM



FOR PULVERISING, BAGGING & STORAGE

by repeated washing with water, the slurry is pumped to the centrifuge for removal of water.

The wet chitosan cake obtained after centrifuging contains about 10% moisture. This is either dried in a double cone rotary vacuum dryer, hot air dryer or in the sun.

The dried chitosan is then coarsely powdered and packed in polythene bags.

Suggested reading

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4. Fish. Technol. Vol. 11, No.1 page 50 by P. Madhavan and K.G. Ramachandran Nair.
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## POTENTIAL USES OF CHITIN AND CHITOSAN

K.G.Ramachandran Nair

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### INTRODUCTION

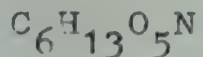
Chitin is the most important organic constituent of the skeletal material of invertebrates. It is found in arthropods, annelids and mollusks. Invertebrates utilize the tough resilient properties of chitin as a body armour and a skeletal support. Although it is widely distributed among the lower animals its only economical source at present is the body peelings from crustacean processing plants. It is a major fishery waste where crustacea are abundant especially in the United States of America, India, Thailand, Malaysia, Philippines, South Africa and Mexico. In these countries, shrimp, lobster and crab shell waste is available in sizeable quantities and the disposal of which now presents a serious problem. Squilla (Orata squilla nepa), which is not commonly used for human consumption is also a good source of chitin. Small non-penaeid prawns landed along the Maharashtra and Gujarat coasts, if processed for protein extract will also form a good source of raw material for chitin. Consequent on the development of squid fishery squid pens are also now available in good quantity which is pure chitin without any minerals and protein.

Chitin is isolated from the shell waste by separating the protein with dilute alkali and demineralising the skeletal

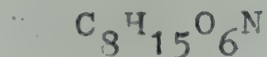
portion with dilute acids. The pure chitin thus obtained is deacetylated at about 100°C with concentrated caustic soda solution. The chitosan thus obtained is washed free of alkali and dried.

Chitin is a high molecular weight polymer of anhydro-N-acetyl-D-Glucosamine (N-acetyl-2 amine-2-deoxy-D-Glucosamine). As in cellulose, the monomer units are linked by  $\beta$  (1-4) bonds. Chitosan is deacetylated chitin (polymer of 2-deoxy 2-amino-D-Glucose). Chitin is insoluble in water and organic solvents. Chitosan is a cationic poly electrolyte insoluble in water, organic solvents and alkaline solutions above pH 6.3 but soluble in most organic acids (formic, acetic, tartaric, maleic and citric) and dilute mineral acids except sulphuric acid. It can form ionic bonds and films. Because of these properties chitosan finds application in many industries.

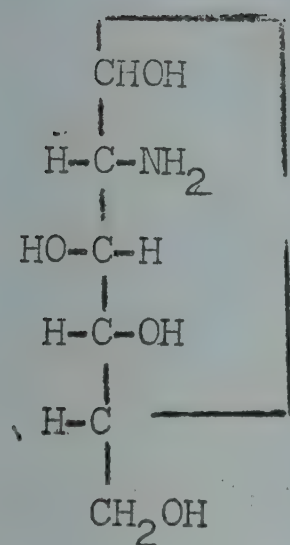
#### Structure of D-Glucosamine, Chitin and Chitosan



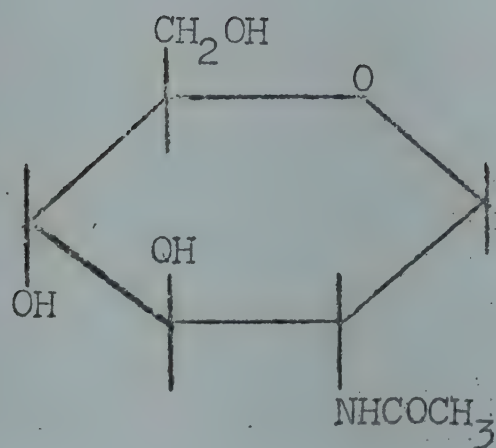
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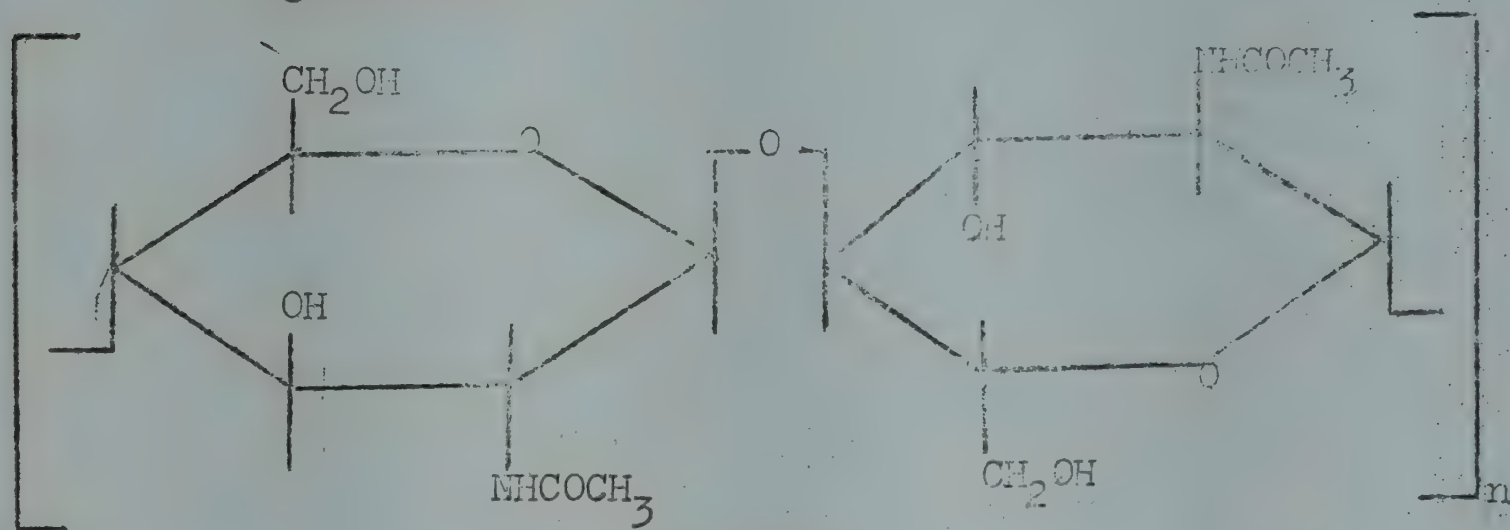
N-acetyl D-glucosamine



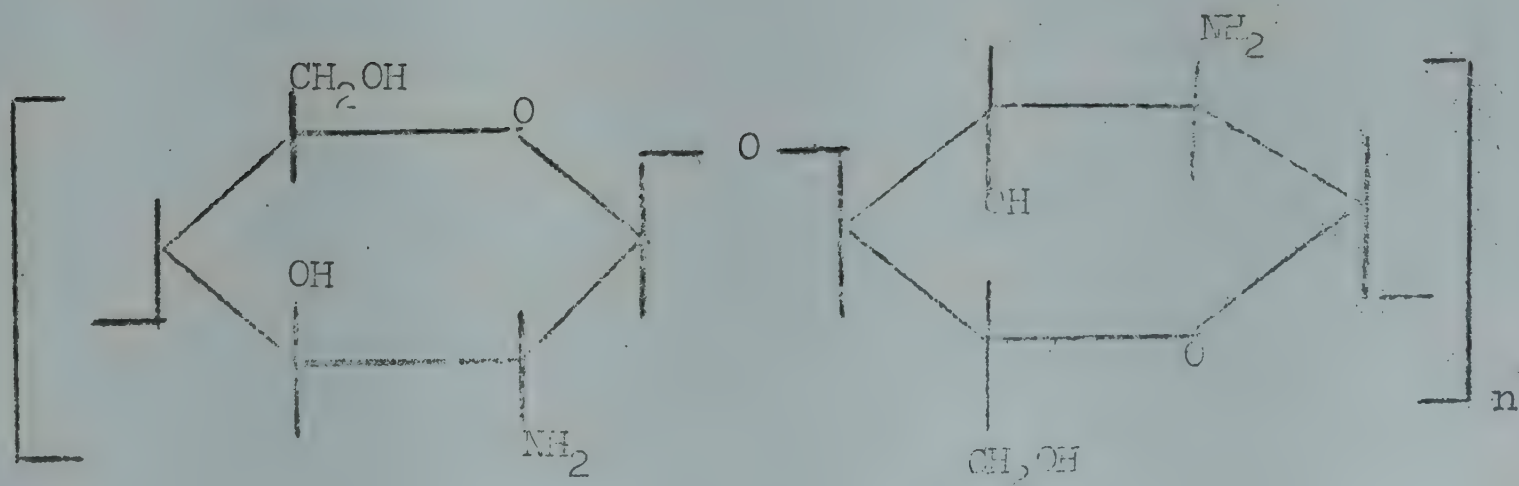
D-glucosamine



N-acetyl glucosamine



CHITIN



CHITOSAN



## Application of chitin and chitosan

Chitin and chitosan finds application in chromatography, chelating polymer for harmful metals, paper and textile additives, textile finishes, glass fabrics, plastic fabrics, batik dyeing, soil repellants, shrink proofing of wool, photographic products and processes, cements, reconstituted tobacco sheets, leather manufacture, coagulants for suspension and medicines.

### 1. Chromatographic application

Examples of general chromatographic application of chitin have been reported by Iwata and Nakabayashi (1974) who removed coloured substances from tea, coffee, apple juice etc. by column chromatography. Thus several fields of chromatography are open to applications of chitin, chitosan and their derivatives, ion exchange chromatography, chelation chromatography, ligand exchange chromatography, affinity chromatography, high pressure liquid chromatography, gel chromatography and thin layer chromatography.

#### Ion exchange chromatography

Acids: Chitosan undergoes slow dissolution in acidic media where anions like acetate, formate or chloride are present, especially at pH values below 2. While it is possible to perform chromatographic separations on chitosan at low pH values, particularly when sulfuric acid or oxalic acid are present, a simple way to obviate the partial collapse of granules, which alters the flow rate of the columns and makes

them unsuitable for prolonged operations is to use epichlorohydrino chitosan (a derivative of chitosan).

Nucleic acids: Takeda and Tomida (1972) used chitin powder as a chromatographic support in thin layer chromatography for the separation of nucleic acid derivatives. The resolution of chitin layers was almost equal to that of cellulose powder for nucleic acid bases (adenine, cytosine, guanine, thymine, uracil, hypoxanthine), nucleosides and nucleotides. Chitin layer permitted a reduction of the developing time. The method was applied in the identification of nucleic acid bases in ribonucleic acid hydrolysate from yeast.

Amino acids: Chitin was also used in thin layer chromatography for the separation of amino acids by Takeda and Tomida (1969). Chitin thin layers have about the same resolution as silica gel layers.

Phenols: Chitin is superior to silica gel and polyamide for thin layer chromatography separation of some phenols as reported by Takeda and Tomida (1969).

#### Inorganic oxyanions

Muzzarelli and Rocchetti (1974) have experimentally verified that the sulfate anion is normally involved in the collection of transition metal ions when present in their solutions and helps in obtaining narrower chromatographic bands of transition metal ions, when sulfate + sulphuric acid

mixtures used to perform elutions, a metal ion can be eluted from a chitosan column; the column can then be recycled.

#### Chelation chromatography:

Chitosan is a most suitable polymer, compared to Dowex A-1, diethylamino ethyl cellulose and other polymers, for the collection of copper from solutions, brines and natural waters. Chelation chromatography can be demonstrated by passing copper sulphate solution through a column packed with chitosan. The solution coming from the column will be ~~SEM~~ colourless and the copper sulphate will be retained in visible blue band on chitosan.

Elements for copper and other transition metals should fulfil several requirements. They should be effective enough to take copper out of chitosan from the narrow chromatographic band. They should not attack or degrade the polymer and they should be absolutely free of the metal ions under study. Chitosan columns conditioned by 0.1 M  $H_2SO_4$  when used for the collection of  $Cr^{+++}$ ,  $Mn^{++}$ ,  $Fe^{+++}$ ,  $Ni^{++}$ ,  $Cu^{++}$ ,  $Zn^{++}$ ,  $Hg^{++}$  chitosan collected  $Hg^{++}$  completely. Used columns were reconditioned by eluting with sulphuric acid and reused.

#### Chelating polymers for harmful metals

Certain metals like mercury and cadmium present special hazards because they are accumulated biologically, but metals like copper, nickel, chromium and zinc, widely used in metal

finishing, are also of concern because their discharge in waste waters may contaminate sewage sludge to the extent that it becomes unsuitable for farm land, reduce the efficiency of sewage treatment processes and harm aquatic life. As an alternative to traditional treatment process, chitosan may be an answer for the prevention of water pollution from mercury, copper and many other elements and radio-active isotopes.

#### Nuclear fission products

Chitosan is well suited for the removal of certain radio isotopes from waters. The resistance of chitin and chitosan to  $\gamma$ -irradiation when applied in chromatography of radioactive solutes has been reported by Maszzareli<sup>&</sup> Tubertini (1972). Titanium, zirconium and hafnium have been studied in this connection. These metal ions are very efficiently collected particularly zirconium. Niobium and ruthenium are also collected by chitin and chitosan. Little is known about lanthanides and other fission products. Adsorption of uranium on chitosan can be considered complete and rapid. This can be eluted from chitosan columns with sodium carbonate solution.

#### Mercury and copper

Methyl mercury acetate can be removed from industrial waters containing small amounts of acetic acid and acetaldehyde with the aid of chitosan. 1 gram of chitosan can adsorb 114 mg. mercury and chloride or acetate ions will not interfere.

Zinc and copper adsorbed on chitosan also do not affect the fixation of mercury. Manganese can be separated from copper in solution by passing the solution through chitosan, when  $\text{Cu}^{2+}$  will be fixed and Manganese  $2^{+}$  is not adsorbed.

#### Paper and Textile additive

Chitosan was found to improve water resistance bursting strength, water vapour transmission rate etc. of paper. Cellulose + chitin fibres can be ~~xxxx~~ spun by mixing chitin viscose and cellulose viscose by the same low temperature method as for the chitin viscose and under the spinning conditions of chitin films. But better results can be expected by mixing chitin viscose with cellulose viscose prepared under the conditions of rayon viscose method.

Chitosan finds application in textile printing also. When reactive dyes are used chitosan treated fabrics absorbs main colour. On giving designs by initial printing with chitosan solution and then passing through the dye bath, the chitosan printed portions absorbs more colour and also gives transparency. If chitosan is used for sizing, it will give a permanent organdy finish to the fabric.

Non woven fabrics also can be made using chitosan treatment on the yarn.

#### Glass fabrics

Chitosan when applied to glass : fibers or fabrics forms a permanent coating with many available sites for the

adsorption of dyes of a wide variety thereby creating a product with physical characteristics inherent to glass fibers and textiles, enhanced with improved chemical capacity of receiving dyes. It also imparts a high degree of fiber to fiber bonding and increases distortion stability, abrasion resistance and improves the general appearance of the fabric.

#### Shrink proofing of wool

Chitosan exhibits very desirable characteristics for use in the shrink proofing of wool. In the treatment of wool, it is suggested to use chitosan salts. The lower fatty acids serve very well for this purpose. The amount of chitosan salt which is deposited on the wool must be controlled so that it is sufficient to give shrink proofing without interfering with the normal <sup>hardness</sup> of the wool.

#### Photography

In the field of photography, chitosan has found important application since processes for rapid development of pictures have been worked out. The choice of chitosan is mainly due to its resistance to abrasion, optical characteristics, to its film forming ability and to its behaviour with silver complexes which are not appreciably retained by chitosan and therefore chitosan can be easily penetrated by solution carrying silver complexes, from one to another layer of a film. Furthermore due to its regularly distributed amino groups chitosan is suitable for forming mixtures with gelatin and

for preventing lateral diffusion of acidic dyes. While products containing chitosan seems to be not yet marketed, it is clear that the photographic field is potentially very important for chitosan applications.

Chitosan can serve as an additive in cement and also it acts as an extender in tobacco. It was also successfully tried for finishing leather.

#### Coagulants for suspension

Chitosan can be used in treating turbid matter and for coagulating the suspended particles. High viscosity chitosan acts as polymer flocculant which can be used for settling ferric hydroxide from zinc sulphate solution. Chitosan is also used as a wine clarifier. Chitosan was found to be more effective than commercial flocculants like Morar floc, separan etc. It can also be used for coagulation and recovering suspended protein particles from solution. In USA, Europe and Japan chitosan is used for the treatment of sewage water.

#### Medical application

Chitosan finds application in stomach antacid treatment, surgical sutures, biodegradable pharmaceutical carrier (mainly for antibiotics) for delayed release, artificial kidney membranes and also in treatment of chronic wounds.

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# THE ROLE OF FISH MEAL & FISH OIL INDUSTRY IN INDIA

U. Sundar Kini

## Introduction

### Fish Meal

As a result of the continued increase in the population all over the world, the population of the earth will be twice that of 1960 i.e. about 4000 millions in the year 2000-fishing and fishing industries have been intensified to provide the necessary supplement of proteins to the diet of the growing population. The demand for feedstuffs containing protein is increasing year by year. One of the most important protein carriers is fish meal.

It is an excellent feed for cattle, pigs and poultry, which provide milk, meat and bacon and chicken. Fish meal has very high contents of digestible pure protein. An average analysis of fish meal shows about 50-65% protein, 8-10% fat, 8-10% moisture and about 9% ash.

Besides the high portion of protein, the vitamins (Vitamin A, Vitamin B Complex, Vitamin D and the mineral substances (Calcium, magnesium, phosphorus, iron copper and iodine) give high nutritive value to the fishmeal.

It must be specially pointed out that fish meal contains large quantities of lysine, methionine and cystine-three of the essential amino-acids which animal bodies cannot synthesize and this makes it an unrivalled constituent of feed stuff. For these reasons, the production of fishmeal has been intensified all over the World.

Requirements for fish meal for livestock feed (5)

Table 1 Clause 2, 1 and 3.3.4

I.S. 4307/1973.

	Indian Fish Meal			
	<u>Grade 1</u>	<u>Grade 2</u>	<u>Lot 800 Bags</u>	<u>Lot 1200 Bags</u>
1. Moisture % by mass max.	10	10	6.8	7.1
2. Crude Protein % by mass min.	60	50	60.83	61.37
3. Ammoniacal Nitrogen % by mass Max.	0.5	0.5	Not done	Not done
4. Crude Fat or Petroleum Ether extract % by mass Max.	10	10	7.03	7.55
5. Acid Insoluble Ash percent by mass max.	3	3	5.10	5.20
6. Chloride (as NaCl) % by mass max.	4	5	0.32	0.28

Note: 2 to 6 are on moisture free basis

Note  
Only 2 is on moisture free basis.

Vitamins:

Fishmeal is an important source of a number of essential vitamins, especially of the water soluble B Group. This group is wellknown numbers some 10-12 different entities

which luckily are fairly widely distributed in nature. An exception must be made in the case of riboflavin B2 where deficiency is very common and with chickens manifests itself by deformities of the bones(crooked toe) in more severe cases it may also be feared that a shortage of certain factors such as pantothenic acid, pyridoxine, nicotinic acid, choline and vitamin B12 may become so great as to considerably retard the growth of pigs as well as of poultry.

The following table shows the average content of the more important B Vitamins of Fish Meal. The figures refer to the Standard whole meal quality.

#### B Vitamins in Fish Meal

Riboflavin	7.30 mg/kg
Niacine	126.00 "
Pantothenic acid	30.60 "
Vitamin B12	0.25 "
Pyridoxine	5.70 "
Choline	4000.00 "

Fish meal cannot claim to be a recognizable source of vitamin. A which must therefore be provided extra in feed rations. On the other hand, through its residual oil content, Fish Meal will be found to supply significant amounts of Vitamin D, of the order of magnitude 5,000 IU.per kilo of meal.

Minerals:

The mineral or inorganic constituents of Fish Meal amounts to some 11% apart from 1-2% of common salt (Sodium chloride) the remainder consists mainly of calcium phosphates, essential for the formation of the animal bone structure. An advantage of the Indian fish meal is the high proportion of phosphorous to calcium 1:1 as against 1:2 for most fishmeal.

Sand and other impurities are absent from the product. On the other hand fishmeal provides ample coverage for many "trace elements" or micro-metals" which have recently been shown to be indispensable for the normal development of the animals.

The following table gives the contents of some of the most important trace elements.

Zinc .....	70 mg/Kg	Copper ....	7mg/Kg
Iodine .....	70 "	Manganese...	4 "
Iron .....	250 "	Cobalt ....	0.1"

Fat:

The fat content of fishmeal is the factor that is most liable to fluctuations, due to unavoidable differences in the raw material and also to variations according to fishing seasons. Since efficient cooking and pressing eliminates excess of oil, the fat content is nevertheless kept within fairly narrow limits.

Fat represents an important source of metabolic energy in the feeding mix. The possibility of making active use of this is being investigated.

Previously the oil in the fishmeal was considerably being considered an disadvantage, due to a possible danger of imparting off-flavour to animal products. However, with a total content of fish oil of 1% or less in the feed mix, no harm will be done to poultry products. This stipulation is easy to fulfil. For slaughter pigs the inconvenience may be eliminated by a judicious feeding schedule. The quantity of fish meal in the daily diet ought not to exceed 150-200 grams.

The oily residue of the meal gradually oxidizes. During this reaction the iodine value decreases, from 130 to 90-95 units, the oil becoming less readily soluble and exerting an even lesser influence on the taste of the animal products. During this oxidation, a certain amount of fatty acids, peroxides and hydroperoxides are formed, compounds which may be considered harmful by some investigators. Freshly produced meal contains about 75 units of peroxide. The value decreases rapidly and by the time the meal is shipped, the peroxide value is insignificant, indicating a definite peroxide value of herring meal without at the same time stipulating age and storage conditions, has thus little practical meaning.

Oxidation, on the other hand, has in the past been the cause of spontaneous heating of the fish meal, which at one time represented such a danger during shipments and storage. Even when no direct fire hazard existed, the quality of the meal was seriously jeopardized. And such oxidative heating is responsible for much inferior quality meal. Fishmeal can be stabilized by means of incorporation of antioxidants Ethoxyquin or BHT immediately after manufacture.

As far as fishmeal is concerned, it has been found that by packing the meal in special paper bags that have a polythene coating, the danger of spontaneous heating has been eliminated. The meal thus retains its optimum quality even after prolonged storage.

#### Analytical Methods:

##### Protein:

Determined by the Kjeldahl method: 1 gr of meal is weighed into a 500 ml digestion flask and 7-8 gr.  $K_2SO_4$  one drop of metallic Hg and 25 ml con.  $H_2SO_4$  are added. Flask is heated until acid boils. Digested 4 hours and cooled, diluted with 250 ml water. Add a few pieces of granulated Zn and 100 ml 40% NaOH solution, containing 10 gr.  $Na_2SO_4$  per litre. The flask is connected to the condenser and 150 ml distilled into a measured quantity of 0.4 N  $H_2SO_4$ . Excess  $H_2SO_4$  is titrated with 0.143 N NaOH, using a mixture of 1:1 methyl red and methylene blue as indicator. Protein is stated as  $N \times 6.25$ .

Fat:

Determined by the Soxhlet ethyl ether method: 5 gr of meal are weighed into a paper thimble and dried for 2 hours at  $103^{\circ}\text{C}$  then extracted with ethyl ether in a continuous extractor for 18 hours (i.e. overnight). The ether distilled off and the residual extract dried for 2 hours at  $103^{\circ}\text{C}$  cooled and weighed.

Moisture:

5 gr. of meal are weighed into a tared steel dish, dried for 4 hours at  $103^{\circ}\text{C}$  cooled and weighed.

Salt:

Determined according to Volhard method. 5 gram of meal are weighed into a 500 ml flask, 300 ml water are added and the content shaken for  $\frac{1}{2}$  hour. More water is added to reach a total volume of exactly 500 ml and the solution is filtered. 50 ml are pipetted into a 200 ml Erlenmeyer flask, 10 ml of 0.1 N  $\text{Ag}.\text{NO}_3$  plus 3 ml conc.  $\text{HNO}_3$  are added. The liquid is heated to boiling and cooled.  $\text{FeNH}_4 (\text{SO}_4)_2$  solution is added as an indicator and excess Ag is titrated with 0.1 N  $\text{NH}_4 \text{CNS}$  until a light brown colour appears.

Total Ash 3 gr. of meal is dried for 4 hours at  $103^{\circ}\text{C}$  and incinerated in an electric muffle stove overnight at  $450^{\circ}\text{C}$ . The crucible is cooled and weighed.

### Fish Oil:

An important bye-product of fishmeal manufacture is fish oil. Fish oil has manifold uses. Refined sardine oil can be hydrogenated to remove the odour and produce a hard fat in the manufacture of soap, lubricants, canning fish etc. Sardine oil has been used in the production of special marine paints. It can be used to prepare factice used in rubber industry as a filler in rubber compounding for functioning as an extender and as an aid to extrusion. Printing ink is another important product developed from sardine oil. After sulphonation and mixing with fatty oils or mineral oil, a fat liquoring composition in the form of a stable emulsion can be obtained. The commercial utilisation of sardine oil or any other fish oil is a highly profitable proposition.

### Utilization of Sardine oil:

As the name suggests the fish has a high body oil content similar to mackerel and other varieties of the Pacific waters. Studies have shown that for most part of the year the fish has a high oil content reaching a maximum of 17% wet weight basis in November, although the oil content falls to around 2% during certain months.

### Industrial Utilisation:

Sardine oil is considered to be a cheap fish oil, having no industrial utilisation except that a small quantity is used for the painting of country fishing boats, batching of

jute and tempering of steel (C.S.I.R. Wealth of India, Raw Materials, 1962). Because of the high unsaturation resulting in the easy susceptibility to oxidation, flavour reversion and the related changes sardine oil had not so far been utilised for preparation of hydrogenated products for soap manufacture or for domestic consumption. It has now been hydrogenated at Kasturi Oil Products, Mangalore and used in soaps. It can be seen from the patent literature that sardine oil can be sulphonated and mixed with fatty oils or mineral oil to obtain a fat liquefying composition in the form of a stable emulsion (Chem. Abstr. 1960). However experimental studies continued on the possibility of finding out alternative commercial uses for this oil in the Central Institute of Fisheries Technology resulted in the preparation of a variety of products which may help in the proper commercial utilisation of this important byproduct. The following will give an account of the major achievements in the field with acknowledgement to Messrs. P. Mathavan and MNN Kaimal of C.I.F.T. Cochin.

#### Factice:

Factice is used in rubber industry as a filler in rubber compounding which has the two important functions as an extender and aid for extrusion. It is generally prepared from vegetable oils like rape seed oil, arachis oil and castor oil. A method has been worked out to prepare it from sardine oil resembling in all chemical and physical characteristics to a commercial sample. Sardine oil whose iodine value has been reduced to the range of 80 to 100 by preheating is treated with 20%

elemental sulphur at 180<sup>o</sup> to 200<sup>o</sup>C. sulphur is added in small amounts while stirring and heating is continued till the reaction subsides. At the final stage of the reaction 10% raw sardine oil is added and allowed to cool. A comparison of the factice thus prepared with a standard commercial factice from vegetable oil is given in table below:

TABLE -2

Comparison of a commercial factice with sardine oil factice:

Acetone soluble matter	Total Sulphur %	Free Sulphur %	Ash%	sp.gr.	Nature of the product
<hr/>					
Sardine Oil					
factice 51.18	12.600	1.198	0.03913	1.002	Soft spongy mass
Commercial					Soft spongy
factice 55.61	10.013	1.295	0.04120	1.020	mass
<hr/>					

Properties of commercial factice and sardine oil factice  
in a tread mix.

	<u>Commercial Factice</u>	<u>Sardine Oil Factice</u>
Moony scorch mts.	16	13½
Tensile strength(lbs/in 2)	2750	2600
Modulus 300%(Lbs/in 2)	1500	1800
Elongation %	550	450
<hr/>		

TABLE - 3

Analytical characteristics of the surface coating materials.

Time of surface drying	4-8 hours
Time of tack free drying	36-48 Hours
Consistency through F.C.No.4	300 $\pm$ 20 secs.
Spreading rate	11-12 sq.m/L/C
Scratch hardness	1300 gms.
Pressure Test	2.3 Kgs.
Flexibility and adesion	0.6 cms.
Stripping test	1300 gms.
Resistance to lubricating oil	No injury
Resistance to SBP Spirit	No injury
Resistance to Petrol	No injury
Resistance to water	No injury.

Table 2 gives a comparative account of the property of the sardine oil factice with that of a standard commerical factice in a tread mix as tested in an industrial concern.

The results from table 2 suggest the vast possibility of replacing the commercial factice of costly vegetable origin with one made from sardine oil.

Surface Coating Materials: (Table -3)

It has been observed that the stearin separated fraction of sardine oil after polymerization under controlled conditions could be made use of as a vehicle for the preparation of ready mixed paint in place of the commonly used linseed oil. The fresh

sardine oil after stearine separation is heat bodied at  $200^{\circ}\text{C}$  with 1% cobalt oxide for 2 hours and further treated with 40% rosin at  $250^{\circ}\text{C}$  for 8 hours. The resinous product thus obtained is incorporated in paint formulations by mixing with pigment dryer and thinner and tested as per the schedule of Indian Standard 101-1964. The results were in conformity with the standard specified by Indian Standards Institution for ready mixed paint.

#### Printing Ink:

Printing ink is another important product developed from stearin separated sardine oil. The stearin separated oil after proper treatments has been found suitable for use as a valcanised oil base for the preparation of printing ink. The oil is heat bodied at  $200^{\circ}\text{C}$  for 4 hours and treated with 40% rosin at the same temperature for  $2\frac{1}{2}$  hours. To the system is added 0.5% sulphur and heated at  $180^{\circ}\text{C}$  till the smell of sulphur almost disappeared. This serves as an effective vulcanized oil base for the final preparation of printing ink. Half-tone black prepared out of the oil base and tried in a printing press gave very successful results.

#### Additive to lubricating oil:

As a result of the introduction of mineral oil lubricant, the importance of air blown oil as additive to lubricating oil has been reduced considerably during recent years. The experiments carried out on the air blowing of stearin separated oil has shown that this can be effectively used as an additive to lubricating

oil. The sample prepared by air blowing at 90 to 100°C for 5 hours during which the viscosity was increased to 24 dynes/sq.cm containing 0.1% hydroquinone is mixed with standard lubricating oil in the proportion of 3:1 and tested for comparison, in a experiment equipment having two identical sturn bearing with a standard commercial lubricating oil. The result of these preliminary experiments showed that air blown stearin separated sardine oil can be used as an additive to lubricating oil.

#### Conclusion:

The foregoing clearly shows that there is vast scope for the development of a substantial industry based on the byproduct obtainable from the most important of our marine fishes. Extraction of the oil in pure form by improved methods in organised extraction centres and conversion of the oil into useful industrial products seem to be the major needs of this vital industry. Substantial results have been achieved in this direction during recent years, which can be taken advantage of by the trade.

#### Hydrogenation of Fish Oils:

In the past, the main reason for hydrogenation of fatty oils was the increase in melting point, to make solid fats from liquid oils. Today the primary ob jective is an improvement of taste and keeping properties. The Norwegian hardening industry comprising the following factories, Jahres Fabrikker A/S, Denofa og Lillsborg Fabrikker A/S and J.C. Martens A/S have been highly active in improving the quality of their hydrogenated marine fat products.

Flavour reversion is a well known problem with all kinds of hydrogenated oils.

Two kinds of flavour reversion can be mentioned.

One results in return of the original oil flavour.

The other is a result of the hydrogenation process itself.

The extensive research work carried out in Norway on flavour stability in hydrogenated fish oil has certainly brought results which seemed impossible 10-15 years ago.

The refining techniques have been improved.

Study of the oxidation mechanism and development of new highly selective catalysts and better hydrogenation equipment have made it possible to selectively saturate the double bonds in the unsaturated fatty acids which is causing the flavour reversion. In this way stable hydrogenated fish oils with low melting points can be obtained.

Today the Norwegian hardening industry are able to supply semiliquid hydrogenated fish oil with melting point as low as  $21^{\circ}\text{C}$  ( $70^{\circ}\text{F}$ ) completely neutral in taste and flavour. The keeping properties compete favourably with comparable qualities of hydrogenated vegetable oils.

The improved quality of hydrogenated fish oil can be compared with that of hydrogenated soybean oil.

Hydrogenated fish oil in margarine and shortening:

Hydrogenated whale oil has been used in margarine and edible fats for more than 50 years. Hydrogenated fish oil has also been used in foods for many years, and since the decline of the whaling the hydrogenated fish oil has completely replaced the hydrogenated whale oil.

The types of fish oil that are marketed changed lately. 10-15 years ago mainly herring oil was marketed in Europe. At present besides menhaden oil from United States, anchovy oil from Peru and capelin oil from Norway are mainly used. Capelin (*Mallatus villasus*) is a small fish of the salmon family.

Fish meal reduction industry had grown up in almost all the fishing countries of the World. Its present position in India is elaborated in the following pages.

India in World Fisheries:

According to the statistics published by the F.A.O. of United Nations, India stands seventh in the Fisheries World as shown in Annexure I.

Excepting Peru and India, the other countries cited above have a variety of fishes in their catches and vast fish waste from fish processing industry from which they manufacture fish meal. Herring, Pilchard, Salmon, Cod and Anchovy are some of them. Whereas Peru depends mostly on catches of Anchoveta, India also relies on species oil sardines and trash fish which are abundantly and cheaply available.

### Size of world fish meal industry:

The size of the fish meal industry can be seen from the disposition of world fish catch furnished in Annexure II.

It will be seen that in India only 5% of its total catches go for reduction into fish meal against the world average of 33%. Large quantities of surplus fish are used for sundrying and salting. Even most of the reduction is not done in the modern way but by drying in the sun and powdering the dried fish. Introduction of modern equipment to utilise the quantities now used for reduction and some of the fish used for sun dried and salted fish will develop a large fish meal industry.

### India as fish meal producer:

In Annexure IV figures of production of fishmeal and their exports by the nine countries are given.

It will be noted that while all countries have made great strides in the production of fish meal even Pakistan and tiny Singapore had shown remarkable effort in this field, India alone had lagged behind in the production and export of fish meal.

### Historical Background:

The existence of abundant sardine fishery on the West Coast is known from time immemorial. About 75% to 90% of all oil sardines caught in India are landed on the West Coast between Karwar and Quilon. Although surprisingly no systematic effort had been made to utilize the catch, crude primitive methods like dumping

the fish in pits and allowing it to rot and purify, ooze out oil and get dried into guano for manure and purified oil for painting boats had been practised. Later by about 1915, improved methods were used for extraction of oil by boiling the fish and pressing it in coir bags by indigenous screw presses. The residue in the bags was dried to form guano. This encouraged utilization of sardines and by 1923, it was reported there were about 700 such establishments, nearly 2 factories per kilometre of the coast line, which produced more than 12,500 tonnes oil. However due to failure of fisheries now and again and especially in the forties and the unattractive prices for guano and fish oil the entire industry languished.

Once again huge quantities of oil sardines were wasted without proper utilisation along the South Kanara District and Kerala coast, fishermen could not dispose of their abundant catches and excess quantities of the catch had to be dumped into pits as before.

With the reappreciation of the value of fishmeal and industrial potentialities of fish oil, there was a spurt of interest in the fish meal and oil industry soon after the second world war and small modern plants were set up at Bombay, Calicut, Cochin and Mandapam with very small capacities. The total capacity of these would not exceed 1000 tonnes of fishmeal per annum.

Raw Material Availability:

Oil Sardines:

As noted above, the main raw material on which the fish meal and oil is mainly based is the abundant oil sardine catches on the West Coast.

The fishes belonging to the family Clupeidae rank first in World production, in India too they constitute about a third of the sea fish production represented by the oil sardine (*Sardinella longiceps*) and other related sardines. (*S. fimbriata*, *S. gibbosa* and *S. sirm*) the anchovies (*Thrissocles* spp) the white bait (*Anchoa mitchilli* spp.), the rainbow sardine (*Dussumieria acuta*) the white sardine, Kowala (coval) and many other clupeoids yielding small scale fisheries. There is large fluctuation in their annual yield, which is most pronounced in the oil sardine, the most valuable clupeid of India.

The species is widely distributed and is landed on the coasts of Arabia, Iran, Pakistan, Ceylon, Annamans and Indonesia, but large scale of shoals seem to be limited to certain areas only, for example the Malabar and Kanara coasts alone in India. The fishery starts after the commencement of the South West monsoon but the peak period is after September extending to January a time when the entire coastal fishing population concentrate their efforts to catch sardine with large boat seines and gill nets so efficiently operated in Malabar.

Although the oil sardine forms the most important fishery of the West Coast landing about 75 to 90% of the oil sardines caught all along the shores of India, it is surprising that no systematic attempts have so far been made to utilize the large quantities of fish oil (fish body oil) that were extracted. In fact this valuable oil had been literally going to waste all these years.

Although the fishery dates back to A.D. 1320 it was under the guidance of Sir Frederick Nicholson who improved the method of production in the early 20's of this century that a fish oil industry developed on the West Coast. In 1922-23 it was estimated that about 12,500 tonnes of sardine oil had been extracted by 700 small extraction units along the coast.

The oil sardine fishery, however, was highly erratic. The statistics of landings of oil sardines on the West Coast show that annual landings vary from 8.8 tonnes (in 1946-47) to about 2,33,034 tonnes (1960-61). The Scarcity and glut are its characteristics and the problem of migration of oil sardines is still unsolved.

However, statistics of the landings of oil sardines on the West Coast from 1925-26 to 1956-57 i.e. for 32 years varied from 8.8 tonnes to 72,000 tonnes with an average of 8,000 tonnes per annum. From 1950-51 to 1961-62 i.e. for 12 years the catches of oil sardine on the West Coast varied from 7,400 tonnes to 2,32,034 tonnes with an average of 74,000 tonnes per annum.

It will be seen, therefore, that the oil sardine fishery has been much better during the last 12 years and basing on an average catch of 74,000 tonnes an estimated quantity of 10,000 tonnes of fish body oil and 15,000 tonnes of fish meal can be produced from this quantity. Assuming that half of this quantity may be used for edible purposes, a quantity of 5,000 tonnes of fishmeal could be manufactured.

This fish body oil can be hydrogenated and the hydrogenated product can be utilised in many industries like soaps, paints, leather curing etc. where valuable edible vegetable oils have been used. In view of the growing demand for vegetable oils this production of hydrogenated fish oil is desirable to relieve the demand for vegetable oils.

There is a huge demand for fish meal from various countries, especially Argentina. If for any reason fish meal is not utilised in this country itself, it should be possible to export this fish meal to foreign countries.

It may be interesting here to present some statistics of the fish oil industry in other countries of the world. These are based on the "Year Book of Fisheries Statistics" published by F.A.O.

Out of the 41.2 million metric tonnes of world fish catch of 1961, 9.6 million metric tonnes of fish or 25% were used to make meal or oil for feeding animals.

For the third year Peru led all other nations with 50,12,100 tonnes or better than 90 percent of her total catch of 52,13,100 tonnes used to make meal and extracted about, 120000 tonnes of oil. Peru's meal production made from anchovetas has multiplied by some 30 times since 1956.

Number two fish meal producer was the United States of America with 10,67,800 tonnes of her 1961 catch of 20,74,400 tonnes of fish used for meal. The U.S. Production was mainly from menhaden. The oil production was about 1,30,000 tonnes.

Other nations during 1961 who used 1,00,000 or more tonnes of fish to make fish meal or oil were Japan 8,43,399 tonnes, Norway, 754,800 tonnes. South Africa and South West Africa 467,600 tonnes Chile 337,600 tonnes. Denmark 316,000 tonnes. Iceland 220,900 tonnes and Canada 187,200 tonnes.

These statistics clearly show the importance and vast size of the fish meal and oil industry in other countries.

The following Annexure V shows the oil sardine landings based on the Statistics of Central Marine Fisheries Research Institute, Cochin in Kerala and Karnataka.

While the annual catch of oil sardine had shown wide variations in the years before 1964, the fishery had shown a remarkable recovery especially during the last decade due probably to various developmental steps taken in our fishing efforts.

The fish meal plants may also draw upon the trash fish catches on the West Coast.

Trash fish are less important fishes caught mainly in trawl nets. They include varieties like silver bellies, flat fishy croaker, pink perch, cat fish, rubber fish, squilla and juveniles of some commercially important fishes.

These trash fish form about 50-70% of the total trawl catches along the West Coast and 25-30% of the total marine catches of India. Because of their small size bony nature and often poor taste, they are not preferred for table purposes. Most often these portions are disposed by dumping into the sea but could be easily used for reduction.

In addition to this brighter, more optimistic and encouraging data have been collected about the fishery potential of the Indian ocean and especially of the West Coast.

#### International Indian Ocean Expedition:

As a result of the intensive study undertaken by the International Indian Ocean expedition from 1959 to 1965 with 13 nations participated fishery potential of India was estimated at 11.8 million tonnes per annum against the present actual catch of 2.2 million tonnes. With intensive fishing the yield of the Indian Ocean is expected to be comparable with those of Atlantic and Pacific Oceans.

Pelagic Fishery Project:

The above estimate further confirmed by the result of the resource surveys of the Pelagic Fishery Resources of the South West Coast of India by the UNDP/FAO Pelagic Fishery Project since its inception in 1971. The assessment of Pelagic resources like oil sardine and Mackerel, has been done in September-October in consecutive three seasons of 1972, 1973 & 1974 by aerial cum-multi vessels survey.

Based on the survey during 1973, the magnitude of the oil sardine resources was estimated as 350,000-400,000 tonnes and that for mackerel resources came to 400,000 tonnes per annum. The Anchovialla resources were calculated at over 3,00,000 tonnes. Other resources of miscellaneous fish was estimated over 100,000 tonnes.

Planning for future abundance:

The actual catches of these fish will necessarily introduce handling and processing problems of a magnitude quite different from those which the country had faced. It would be necessary to plan for a fuller and better utilisation of these resources. Fish meal production will be one of these solution.

As a result of the Fourth and subsequent plans during which large sums could be invested, fishery development would add to the fishing effort. It is estimated there would be more than 5500 mechanised boats, 300 trawlers in addition to thousands of medium and small boats. Fishing harbours service

facilities and other utilities would enable the potential resources mentioned above to be explained fully.

If these plans are pursued with vigour and vision a production of 25,000 tonnes of fishmeal and 10,000 tonnes of fish oil equivalent to 125000 tonnes of fish should easily be reached. At present prices these will be worth nearly Rs.10, crores.

#### Fish Meal Industry:

In India there are about 25 modern fish meal plants with a daily capacity of processing about 500 tonnes of fish per day and 50,000 tonnes in the season of 100 days on the average. We can expect about 10,000 tonnes of fishmeal of International standard. Add to this about 15,000 tonnes produced by unorganised sector totalling the annual availability to 25,000 tonnes. The quantity produced by unorganised sector is 5,000 tonnes but recent information puts it at 15,000 tonnes per annum. The internal demand of the animal feed manufacturers does not exceed 5,000 tonnes (recent estimate) leaving about 20,000 tonnes per annum for export. The export of this quantity will fetch Rs.2 to 3 crores of foreign exchange. There is no compelling reason to ban the export of this potential surplus".

A typical plant description:

The following describes briefly the outlines of a fish meal plant.

PLANT LIST

<u>Item</u>	<u>Description</u>
1	Cooker
2	Double Screw Press
3	Screw Conveyor
4	Dryer
5	Screw Conveyor
6	Hopper
7	Grinding Plant
8	Screen
9	Centrifuge
10	Evaporation Plant
11	Hot Air Fan & Ducting
12	Plant Control Panel

III Process Description

Raw material is fed to the cooker and cooking is carried out in a steam heated vessel and should normally take some 15-20 minutes depending on the type and quantity of raw material being processed.

The cooked fish is fed by gravity into the double screw press where the oil and free water are expelled and collected in a

drain tray under the press. The press cake is passed through the press and transferred to the dryer via a breaker conveyor which 'Fluffs' the cake up thus ensuring better drying results. After drying to the required moisture level, the meal is taken from the dryer to the grinding plant by screw conveyor.

The oil and free water are then passed to a screen where any solids are collected and recycled to the dryer. The liquor is passed to a Centrifuge where the oil is separated off and the stiff water is passed on to an evaporator where it is concentrated and recycled to the dryer.

Malodorous gases from the process are drawn off by a fan through a ducting system.

#### IV. Mechanical Specification:

##### 1. Cooker

The cooker is a steam jacketted vessel built to the requirements of B.S.S.1500 Class III("Unfired Pressure Vessels"). It is constructed from Carbon steel plate to B.S.S. 1501 -151 26A. Material is transported through the shell by a steam heated screw shaft. In addition to the indirect heating system as described, provision is also made for the injection of live steam into the fish if this is required. Adequate provision is provided for the removal of condensate and air from the steam spaces. The drive unit is  $7\frac{1}{2}$  H.P. variable speed unit and a chain drive which gives a shaft speed of 1-4 r.p.m.

## 2. Double Screw Press

The press consists of two contra rotating screws which have a tapered shafts thus giving the required squeezing effect by volume reduction. The screws are enclosed by a double skinned perforated tube, the inner lining being stainless steel and the outer being 3/8" thick mild steel. The tube is braced by 1" thick bridge piece which are split along their centre line thus allowing easy access to the screws. The complete unit is supported by steel channels and enclosed by an aluminium casting.

The drive provided by a 7½ H.P. variable speed unit giving a shift speed of 1-4 r.p.m.

## 3. Breaker Conveyor

The transfer conveyor from press to dryer has a number of paddle blades which create a breaking action which effectively breaks up any large pieces of press cake. The conveyor is 6" dia and has a 1½ H.P. drive unit.

## 4. Dryer

The dryer consists of a cylindrical shell enclosing a hollow shaft which is fitted with saucer shaped hollow discs. Forward movement of the drying meal itself is provided by adjustable paddle blades which are fixed to the periphery of each disc. Residence time of the meal in the dryer controlled by a Weir type gate at the protrude between each set of discs thus preventing any build up of drying meal between discs.

The drive is a 20 H.P.

5. Screw Conveyor

6" dia x 18'0" long approx. transferring meal from dryer to conveyor feeding the grinder.

6. Feed Hopper to Grinder:

A mild steel hopper suitable supported and feeding into the vibratory feeder above the grinding plant.

7. Grinding plant

Christy-Norris LB 7 2 Briton Grinder capable of handling up to  $\frac{1}{2}$  ton/hr and comprising the following items:

- |                    |   |
|--------------------|---|
| 1. Vibrator Feeder | 5. Dust Filter Unit                               |
| 2. Grinder         | 6. Cyclone  |
| 3. Magnet          | 7. Two way bagging arrangement at cyclone outlet. |
| 4. Fan             | 8. 15 H.P. Motor.                                 |

8. Screen

From the press liquor tank the liquor is passed through a Richard Simon screen where any solids are separated.

9. From the screen the press liquor is passed to a Westfalia Separator type SAO G 3016 where the oil is separated.

10. Evaporation Plant:

An evaporation plant of the strataup type manufactured by Henry Balfour and Co shall be installed to accept stickwater which shall be concentrated before being offered to the dryer along with the press cake and solids from the screen.

Marketability:

The demand for fish meal and oil is ever increasing not only from abroad but also internally for feeding and industrial uses. There would be no difficulty in selling the products profitably.

Fish Meal for Animal Feed Industry:

The Animal Feed industry had developed rapidly in this country of late and there are 50 big plants in addition to innumerable small ones with a production of a million tonne capacity of feeding stuffs. They alone would require 10,000 tonnes of fish meal. But the animal feed industry is still shy of using this excellent constituent due to traditional bias or lack of scientific conviction.

Export Potential for Fish Meal:

But still till such time as the internal demand rises, there is a huge export market as can be gauged from Annexure C-VI and VII showing export demand from developed and Asian countries which are easily reached from India.

Pakistan and Singapore, already gone far ahead of India in this field of export of fish meal. /have

Beginning Has been Made:

However a beginning has already been made in India to take advantage of the export potential for fish meal. Mukka Oil and Seafood Industries had exported during the last two years to Iran nearly 500 tonnes of fish meal worth over Rs.15 lakhs.

Fish Meal & Oil Industry:

It will be evident from the foregoing exposition that with the availability of abundant raw material backed by potential further supplies and an increasing domestic and export demand for fish meal and ready market for fish oil, the establishment of fish meal and oil plants will be most appropriate now.

## ANNEXURE I

## World Nominal Catch

FAO Year Book of Fishery Statistics 1977 Vol. 44

Country	1970	1971	1972	1973	1974	1975	1976	1977
	MT	MT	MT	MT	MT	MT	MT	MT
1. Japan	9366500	9949600	10272500	10747700	10804586	10524204	10662188	10,733316
2. U.S.S.R	7253100	7336900	7756900	8618700	9235594	9935606	10133670	9,352204
3. China	6255000F	6880000F	6880000F	6880000F	6880000F	6880000F	6880000F	6,880000F
4. Norway	2985700	3074900	3185600	2987400	2644930	2550438	3435256	3,562213
5. U.S.A.	2891600	2960600	2842700	2857700	2928799	2898373	3175558	3,101544
6. India	1756100	1851600	1637300	1958000	2255313	2328000	2400000	2,540000
7. Peru	12534900F	10528600	4725200	2328500	4144858	3447490	4343125	2,529995

## ANNEXURE II

Disposition of World CatchPercentage of Total World Catch Year Book  
of Fishery Statistics Volume 43.

	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
For Human Consumption:	63.2	64.5	70.3	73.1	70.4	70.6	69.5	72.0	
Marketing Fresh	26.3	26.9	28.7	30.1	29.4	28.7	27.9	30.5	
Freezing	13.9	14.5	16.2	17.4	16.4	16.8	17.4	17.1	
Curing	11.5	11.0	12.1	11.8	11.4	11.7	11.2	11.1	
Canning	11.5	12.1	13.3	13.8	13.2	13.4	13.0	13.3	
For other									
Purposes:	36.8	35.5	29.7	26.9	29.6	29.4	30.5	28.0	
Reduction A	35.4	34.1	28.2	25.4	28.2	28.0	29.1	26.6	
Miscellaneous Purposes:	1.4	1.4	1.5	1.5	1.4	1.4	1.4	1.4	
World Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
Total World									
Catch	70696400	71288700	66924400	67677900	7134000	71003700	74717200	73,501,000	

# ANNEXURE III

## DISPOSITION OF CATCHES BY COUNTRIES

FAO YEAR BOOK OF FISHERY STATISTICS VOL. 45

In 1000 Metric Tons.

Country	1971	1972	1973	1974	1975	1976
INDIA	<u>1845.0</u>	<u>1640.2</u>	<u>1959.0</u>	<u>2255.3</u>	<u>2328.0</u>	<u>2400.0</u>
Marketing fresh	1218.0	1127.6	1278.6	1437.0	1616.4	1663.2
Freezing	97.5	83.2	103.5	101.1	65.2	124.8
Curing	23.0	23.0	23.0	24.0	1.0	424.8
Sun dried fish	249.6	286.0	379.7	524.0	441.6	...
Salted fish	107.9	...	...	...	...	...
Canning	13.1	9.5	15.9	9.9	4.8	7.2
Reduction	105.6	81.7	104.4	111.6	139.8	120.0
Miscellaneous						
Purposes	53.3	53.2	73.9	71.7	60.2	60.0
Offal for						
reduction	...	...	...	...	...	2.5 m.t.

# ANNEXURE IV

## E X P O R T S

CCOUNTRY	1970	1971	1972	1973	1974	1975	1976	1977
Peru	1903400	1762100	1625900	356700	618000	783500	594100	412025
Japan	24500	37700	28600	17800	31300	49300	49000	37466
U.S.S.R.								
Norway	248900	318800	381900	326900	281800	324900	415500	461557
U.S.A.	4300	9100	9400	33300	50400	10700	30100	32752
S.Africa	131400	77300	114200	79000	78000	147300	45200	9600
India	100	0	200	5900	9000	862	2256	2490
Pakistan	11900	9200	16300	23000	14300	11946	11025	11025F
Singapore	10600	9200	10200	6000	5800	8100	5000	6740

## ANNEXURE IV.

## FISH MEAL PRODUCTION &amp; EXPORTS FAO BOOK OF FISHERY STATISTICS 1977 Vol.45.

## COUNTRY PRODUCTION

COUNTRY	1971	1972	1973	1974	1975	1976	1977
Peru	934.6	893.7	8420.0	877.6	93687.4	98886.3	947497.0
Japan	503.8	557.7	5596.5	591.7	56753.9	55601.1	575642.8
U.S.S.R.	406.1	439.7	488.7	541.8	637.6	634.0	579.1
Norway	369.5	356.6	333.4	309.2	3316.3	3454.1	33454.5
U.S.A.	357.3	370.1	377.3	389.0	369.2	394.0	359.5
S.Africa	273.0	244.6	271.4	251.7	244.3	208.3	171.4
India	0.0	0.2	15.9	1.0	0.0.9	2.3	-
Pakistan							
Singapore	9.2	10.2	6.0	5.8	8.1	5.0	5.7



## ANNEXURE V

## MARINE FISH LANDINGS

Year	KERALA STATE				KARNATAKA STATE				TAMIL NADU				INDIA			
	Oil Sardine	Other Sardine	Total Marine Fish		Oil Sardine	Other Sardine	Total Marine Fish		Oil Sardine	Other Sardine	Total Marine Fish		Oil Sardine	Other Sardine	Total Marine Fish	
1970	191683	6139	392880		33821	2034	115205		46	16982	149106		226984	56239	1077466	
1971	194977	11403	445347		11836	491	103724		45	23562	160619		209261	61283	1161389	
1972	104423	16754	295618		15610	1563	92576		146	21051	155153		127668	44629	980049	
1973	122783	62421	448269		15495	1164	91484		45	26059	182419		144395	105523	1220240	
1974	102135	31335	420257		20784	228	78263		-	15530	175713		126676	83921	1217797	
1975	97183	33652	420836		52701	775	87494		-	35610	221215		159240	12117	1422693	
1976	123337	34305	331047		41451	641	95283		-	25169	226078		169332	100000	1352855	
1977	117356	20754	345037		31145	180	97152		714	26259	206045		150130	65724	1259782	
1978	119937	11713	373339		46707	2572	152860		36	21050	212899		168078	52838	1403607	
1979	116834	15914	330509		33080	4753	126384		1011	32289	235008		153971	68351	1388380	

# ANNEXURE VI

## FISH MEAL AND FISH OIL EXPORTS FROM INDIA.

Year	Fish Oil		Fish Meal	
	Quantity (mts)	Price (Rs.)	Quantity (mts)	Price (Rs)
1970	194178	3,15,060	74,250	74,064
1971	54690	90,726	-	-
1972	148402	2,39,592	2,36,957	1,91,429
1973	48942	58,050	30,52,721	59,18,172
1974	393168	8,40,387	58,67,370	1,46,74,278
1975	219793	5,16,813	2,33,188	3,40,500
1976	189268	4,82,732	22,56,054	38,84,814
1977	45331	1,22,061	35,94,516	80,27,183
1978	262277	15,08,150	14,57,749	39,52,056
1979	822908	48,51,866	8,96,150	25,61,257

## FISH AND SHELL FISH PICKLES

K.K. Balachandran

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Semi preserves called pickles, marinades etc. prepared out of different fish and shell fish are very popular in several countries. Salt and acetic acid are the main preservatives used in their processing. Fish like sardine, mackerel etc. used to be pickled in India, particularly in the South West coast using salt and Malabar tamarind.

Hereunder is given an account of preparation of the so called hot pickle from fish and shell fish, in par with the similar already popular, vegetable pickles, which is a ready to serve item to be used in conjunction with Indian dishes. This is a non-traditional item of preparation involving fish and shell fish which is now becoming popular.

Pickle is a high acid food of which the pH varies from 3 - 4 which is contributed by its high acetic acid content. At this pH bacterial spoilage is not a serious problem, whereas the proteolytic enzymes in fish will still remain active. However, if the fish is well cooked enzymic action also can be taken care of. However, at higher concentration of acid disintegration of the meat can take place due to acid hydrolysis. Therefore, salt also is used in substantial quantities in pickles to take care of the problem of hydrolysis of meat. In salt-acid solutions the fish flesh becomes firm.

Prawn and fish pickles have already become popular

in markets. Pickles made out of clam and mussel meat are the recent introductions in the market. The technology of preparation of clam and mussel meat pickles was widely popularised in the 'Lab-to-land' programmes of the Central Institute of Fisheries Technology in the recent past with very good response from entrepreneurs and the products have been well accepted by the consumers. At present there are a number of parties regularly processing clam and mussel meat pickles and marketing within the country and abroad. Similar is the case of prawn and fish pickles too.

Method of processing:

a) Fish pickle

A recipe for fish pickle is given below:

- |   |           |
|---|-----------|
| 1. Fish (dressed and cut into small pieces) | - 1 kg.   |
| 2. Mustard seed                             | - 10 g.   |
| 3. Green chilly (cut into pieces)           | - 50 g.   |
| 4. Garlic (peeled)                          | - 80 g.   |
| 5. Ginger (peeled and chipped)              | - 80 g.   |
| 6. Chilly powder                            | - 35 g.   |
| 7. Turmeric powder                          | - 2 g.    |
| 8. Gingilly oil                             | - 200 g.  |
| 9. Vinegar                                  | - 400 ml. |
| 10. Salt                                    | - 100 g.  |
| 11. Sugar                                   | - 10 g.   |

Mix the fish thoroughly with 5% of its weight of salt

and keep for 2 hours. Light salted and partially dried fish also may be used. Fry the fish in minimum quantity of oil. Set apart the fried fish.

Fry the ingredients 2-5 in the remaining quantity of oil and then add chilly powder and turmeric and mix well under low flame for a few minutes. Remove from fire, add fried fish, vinegar and sufficient quantity of boiled and cooled water to cover the ingredients well. Mix thoroughly, add sugar and salt to taste. Cool well and transfer to clean sterile glass bottles and seal with acid proof caps. Take care to see that there is a layer of oil over the contents in the bottle.

b) Prawn pickle

Recipe

1. Prawn meat	- 1 kg.
2. Mustard seed	- 10 g.
3. Garlic (peeled)	- 100 g.
4. Ginger (peeled and chipped)	- 100 g.
5. Green chilly (cut into pieces)	- 50 g.
6. Chilly powder	- 30 g.
7. Turmeric powder	- 2 g.
8. Gingilly oil	- 200 g.
9. Vinegar	- 400 ml.
10. Sugar	- 5 g.
11. Salt	- 100 g.

Proceed as in the preparation of fish pickle.

c) Clam meat pickle

Recipe

- |   |           |
|---|-----------|
| 1. Clam meat (shucked from cleansed and steamed/boiled clams) | - 1 kg.   |
| 2. Mustard seeds  | - 10 g.   |
| 3. Garlic (peeled)  | - 80 g.   |
| 4. Green chilly (cut into pieces)                             | - 50 g.   |
| 5. Ginger (peeled and chipped)                                | - 80 g.   |
| 6. Chilly powder  | - 40 g.   |
| 7. Turmeric powder  | - 2 g.    |
| 8. Gingilly oil   | - 200 g.  |
| 9. Vinegar  | - 400 ml. |
| 10. Salt  | - 80 g.   |
| 11. Sugar   | - 5 g.    |

Clam meat should be shucked from 'cleansed' clams as described in the process of canning (see canning of clam and mussel meat). Fry the thoroughly cleaned meat in oil and proceed as in other cases. Finally mix thoroughly with salt and bottle the product.

d) Mussel meat pickle

Mussel meat pickle also can be prepared in similar lines as proposed for clam meat. However, the shucked meat is freed of its stomach contents and cut into smaller pieces before used.

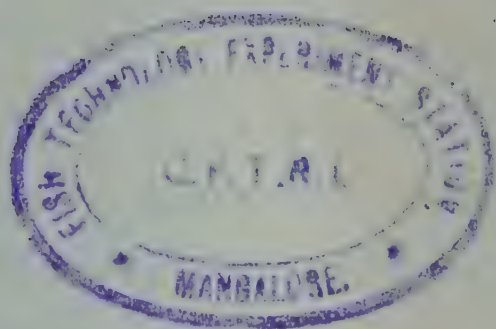
It is very important to make sure that there remains a layer of oil over the product when it is bottled. This will

effectively prevent the contents from contact with air vis-a-vis functioning as a seal against bacteria from external sources.

It is equally important to use only fresh raw material for making pickles. Whereas big fish could be cut into smaller pieces or chunks or fillets discarding the bones, small varieties of fish can be used after dressing and cutting into smaller pieces. Powdered salt with low calcium content should be used in pickles. Higher calcium content will toughen the texture besides affecting the flavour.

If desired powdered spices can be incorporated to improve the flavour. If required, sodium benzoate also can be used at low levels to check the growth of mold.

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# CANNING TECHNIQUES FOR CLAM AND MUSSEL MEAT

K.K.Balachandran

Clam and mussel are two important sources of protein rich food abundantly available in the country. Clam is found widely distributed in the inland water bodies, estuaries and bar mouths. Vembanad lake, the largest lake in the south west coast of India is known as the richest source of clam in Kerala. Clam fishery of Kerala is supported mainly by Velorita and Meretrix spp: Mussel (Perna viridis and Perna indica) are found in the littoral and sub littoral zones of both west and east coasts where they are attached to the submerged rocks by means of byssus threads.

Even though there is no reliable statistical account available on the potential of clam and mussel resources in the country, it is well known that there is near inexhaustible resources of both, the present rate of exploitation being far less than the potential availability. The recent successful development of culture technique will serve as another boost to the availability of mussel in the country. Whereas mussel is collected exclusively for its meat for food purposes, clam is collected mainly for its shell which is a very valuable industrial raw material. Meat is only its by product.

Clam and mussel meat have the following proximate chemical composition.

	Clam meat ( <u>Velorita</u> spp.)	Mussel meat ( <u>Perna viridis</u> )
Moisture %	73 - 79.5	78.24 - 80.28

	Clam meat ( <i>Velorita</i> spp.)	Mussel meat ( <i>Perna viridis</i> )
Protein %	10.9 - 11.27	11.08 - 12.61
Fat %	2.5 - 3.60	2.38 - 3.02
Glocogen %	6.1 - 6.68	5.36 - 7.91
Ash %	2.1 - 2.9	3.06 - 4.21

The content of relatively high quantity of glycogen renders their taste near to that of prawns,

Both clam and mussel are sedentary animals which, while under water, remain little agape and feed on the micronutrients in water by the mechanism of 'filtration'. Hence sand and mud find access to their stomach and those, if allowed to remain, cause grittiness to the meat. Their habitat and hence their meat are likely to be polluted with faecal and pathogenic bacteria. Contamination, though to a lesser extent, with heavy metals and pesticide residues also cannot be ruled out.

If these organisms are bacterially polluted their purification is rather simple since they cleanse themselves of all polluting bacteria if kept in clean water (of their habitat) for a number of hours. The same treatment can also free them from most of the sand in their stomach. In some places, mussel is kept in clean sea water in tanks over two nights with a change of water on the second day. Keeping the harvested mussel in net bags in clean areas in the sea also is practised with great success. In certain parts in the Atlantic

coast clam is known to be stored in wooden crates submerged in clean areas in the sea for cleansing. It has been experimentally proved in the laboratory that starvation for 24 hours followed by chlorination at 5ppm level brings down the sand content to the level of p. 0.02%. No faecal or pathogenic bacteria has been detected in so cleansed mussel meat. However, a continuous monitoring of the quality of meat and water in the surroundings with respect to incidence of pathogenic and faecal bacteria as well as contamination with heavy metals and pesticide residues is absolutely necessary. It will be ideal for greater safety to check all batches of mussel/clam so cleansed for any probable incidence of paralytic shell fish poisoning since such incidences have been reported with respect to clams of Atlantic waters.

Clam/mussel purified by the above method is cooked either in steam in a retort or in open vats till all open up their mouths which makes the shucking of the meat easy. Meat can be shucked from mussel by hand whereas from clam it can be shucked either by hand or using an indigenous device called 'shaker'. The shucked meat is cleaned well and blanched in boiling brine. Blanching in 5% brine for 5 minutes has been found suitable for both clam and mussel meat.

Blanched meat is cooled under air blast till the surface is dry and then packed in cans according to the declared drained weight. Normally cans of size 301 x 203 (128 g drained weight) are used. To this is

added the appropriate quantity of the filling media (brine, oil or sauce) exhausted in steam followed by hermetical seaming. The seamed cans are processed in steam at  $0.74 \text{ Kg/cm}^2$  pressure for 30 minutes. By this processing the material attains the required texture as also meets the requirements of sterility. At the end of processing the cans should be immediately in chlorinated water.

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## MANUFACTURE OF FISH SAUSAGE

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Fish sausage is nearly 75 years old in Japan.

While it is a highly popular product in Japan and Korea and recently introduced in Australia, U.S.A. and Sri Lanka, it has not caught the attention of other countries so far. The technology of sausage making is now known to India and Jakarta through Japanese collaboration but not yet commercialised. In Japan, although this product was developed around 1925, it took a long time to catch the market and only since last two decades it is being marketed in a big way. In 1968 the production of fish sausage and Ham, which is also a similar product like sausage, totaled 1,61,753 tons. However, the initial unpopularity of this product was mainly due to poor quality, fishy odour and the need for a suitable sausage casing. The key to the success of this product was the advent of 'ryphan' sausage casing (rubber hydrochloride film casing) and the accumulated scientific knowledge on the processing of Japanese fish paste "Kamaboko", which has been eaten by Japanese from ancient times. The other factors contributing to its success are: careful control of each step in the manufacture of this product, much publicity given by the big fishing companies and the gradual increase in the bread-eating habits of Japanese, with which sausage goes well. Sausage manufacture in Japan is

The seasoning material (sugar, salt, sodium glutamate, ribotide), colouring material, preservatives and condiments prepared separately are added to the meat in the mortar (silent cutter). At the end of the operation, small cubes of raw pork fat/vanaspathi (about 7-10%) are added to the mixed fish meat. The ingredients are then stuffed into one of the available types of sausage casings. The finished product which is prepared by cutting in a silent cutter is called "meat sausage style-fish sausage". If a stone grinder is used instead of a silent cutter, the finished product is called "kamaboko style-fish sausage".

During the process of cutting in a silent cutter or in a stone grinder, the seasoning materials, starch and others are added to the mixture of crushed meat near the end of operations which then go on for another 10 or 20 min. Polyphosphate sodium glutamate, sodium 5'-ribonucleotide, sugar, spice and condiments, smoke flavour, salt are added in consecutive order into the crushed meat.

Preservative:

Sodium or potassium salts of sorbic acid (Up to 2.0g per 1 kg of fish sausage) and furylfuramide (2- (2-furyl)-3- (5-nitro-2-furyl) acrylamide) (0.02 g per 1 kg of fish sausage) are permitted in Japan. Recently fat coated sorbic acid and high temperature processing are being used in Japan since furylfuramide (AF2) has been banned.

Casing:

"Ryphan" film casing (rubber hydrochloride). Its strong points are its light and strong structure, not affected by chemicals and oils or by heating and cooling. Does not permit water vapour or air to penetrate in either direction. The film sheet is tough and stuffing is easy. The film is non-combustible, tasteless and odourless. However, its only defect is, the rubber becomes old after some months and hydrochloric acid gas is freed from the film which then becomes fragile.

"Kurehalon" (vinylidene chloride casing) resembles 'Sara' of Dow chemicals Inc. It is a transparent, shrinkage and waterproof film. Its melting point is  $160^{\circ}\text{C}$ . It is stable to fats, oils, organic solvents and extremely hard to break, tear or puncture. The shrinkability of the film makes possible the very tight packaging of sausage.

Raw material considerations:

Fish meat with low and strong elasticity can be employed but has to be judiciously mixed to get the right texture, which is neither too strong like that of Kamaboko nor too weak. Red flesh meat is generally weak with respect to elasticity after processing whereas white flesh meat has a strong elasticity.

White flesh as well as red flesh fishes can be used for sausage making. However, fish having a large amount of dark muscle such as mackerel, and sardines are not suitable.

Fishes suitable for sausage

Generally cheaper fish are employed. Among the low cost fishes caught in our coasts thread fin bream(perches), croaker, lizzard fish, ribbon fish and lactarious have been found to be suitable. Among other red flesh fishes different kinds of tuna, particularly blue fin tuna, Indian tuna ( a variety of blue fin tuna) are considered for their taste and employed in fish sausage. Several kinds of marlin fish like striped marlin(tetrapturus mitsukuri), blue marlin(tetrapturus amplus), broadbill sword fish, sail fish are employed. Blue marlin is particularly suitable for sausages because of its good taste, white flesh and strong elasticity. Certain varieties of skipjack, bonito, salmon and whale are also used for sausage making. However in the case of fishes preferred for table purposes or for any other product manufacture, only the damaged fish or meat from the unutilized portions of the body is employed for sausage making.

Among the white flesh fishes, cods, sharks, Alaska pollack rays and horse mackerel are used. The meat of Saurida sp., sharks and rays have a strong elasticity but those of cod and Alaska pollack are weak. Sharks and rays are not eaten as daily dishes because of their ammonical odour and can be utilized for blending sausage meat.

The red flesh meat of which the freshness has become low appears blackish red and it can be reddened by treatment with nitrite. For such meat if ascorbic acid is added, the methaemoglobin or metmyoglobin are some times reduced to their original bright red colour. Recently even fatty fishes like oil sardine are being used in Japan for sausage making.

Keeping quality of fish sausage:

Microbiological:

Fish sausages are generally processed at comparatively low temperatures because, if processed at above  $100^{\circ}\text{C}$ , the elasticity of the ground fish meat after processing will decrease, becoming fragile and the added fat will melt. Therefore the thermotolerant and spore-forming bacteria survive. The relation between the processing temperature and the survival of bacteria is shown in the table below (Yokoseki, M 1958).

T A B L E

Relation between processing temperature  
and survival of bacteria

Temp. of the centre of fish sausage (°C)	Fish sausage without sugar		Fish sausage sugar added	
	Bacterial	Species of isolated	Bacterial	Species of
	Count (in 1 g)	bacteria	count (in 1 g)	isolated bacteria
60	$5.3 \times 10^5$	Microc.varians M.epidermidis Bac.megatherium Bac.firmus	--	--
65	$6.3 \times 10^4$	Bac.megatherium Bac.firmus Bac.subtilis	$6.1 \times 10^4$	Bac.coagulans Bac.megatherium
70	$6.3 \times 10^4$	Bac.coagulans	$5.0 \times 10^4$	--
75	$3.8 \times 10^4$	--	$3.2 \times 10^4$	--
80	--	--	$1.0 \times 10^4$	--
85	--	--	$5.6 \times 10^4$	--
88	$8.1 \times 10^3$	Bac.subtilis Bac.megatherium	$7.5 \times 10^3$	Bac.cereus

Based on these findings preservatives which prevent or retard the growth of surviving bacteria are used.

Well processed sausages normally keep well for a month at ambient temperatures. Some fish sausages spoil within a week's time mainly due to nonhomogeneous mixing of the preservative in the

meat or due to improper sealing of the ends of casings which allow bacteria to enter during cooling of sausages or during storage.

#### Chemical:

Analysis of a large number of commercial samples (Ogasawara et al., 1957) which were normal in appearance showed on an average acidity of 4.61, total nitrogen 2.82%, VBN 32.83 mg %, TMA 19.42 mg% bacterial count  $45 \times 10^7$  for aerobic bacteria,  $67 \times 10^3$  for anaerobic bacteria (non-pathogenic) and coliforms, yeast and molds and histamine were not detected. Such fish sausages are sold and are safely edible.

#### Types of spoilage in fish sausage:

The type of spoilage differs with the temperature of storage. If held at  $15^{\circ}$  to  $27^{\circ}\text{C}$  for 30 days the added pork/ vanaspathi softens, the product develops a yellow discolouration and a stale odour. On the other hand if held at  $32^{\circ}$  -  $37^{\circ}\text{C}$  for 10 days, indications of spoilage such as, swelling of the casing, discolouration of the contents, softening, yellow discolouration of meat. Types of spoilage may be listed as follows:

1. Gas formation: .. Swelling of casing due to gasses such as ammonia or  $\text{CO}_2$  by various species of bacteria. Lactobacillus sp. (aerobic or anaerobic, nonthermotolerant bacteria) and Clostridium sp. (anaerobic, Sporeforming and thermotolerant).

2. Acid formation: .. Due to growth of non-gasforming bacteria resembling those which cause "flat sour" of canned foods. (Lactobacillus sp. non-spore-forming and non-gasforming).
3. Putrefactive odour : .. With or without gas formation
4. Softening: .. Of meat to mud-like consistancy due to the action of proteolytic bacteria.
5. Discolouration: .. Generally begins at the mouth of the casing and spreads all over the surface and sometimes the casing partially swells. (Streptococcus sp. facultative, anaerobic, non-thermotolerant).
6. Liquifaction: .. Occures between the casing and the surface of the contents, sometimes with partial swelling of the casing.
7. Black or brown spots: .. On the surface of the sausage and inside of the casing (Bacillus sp)

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